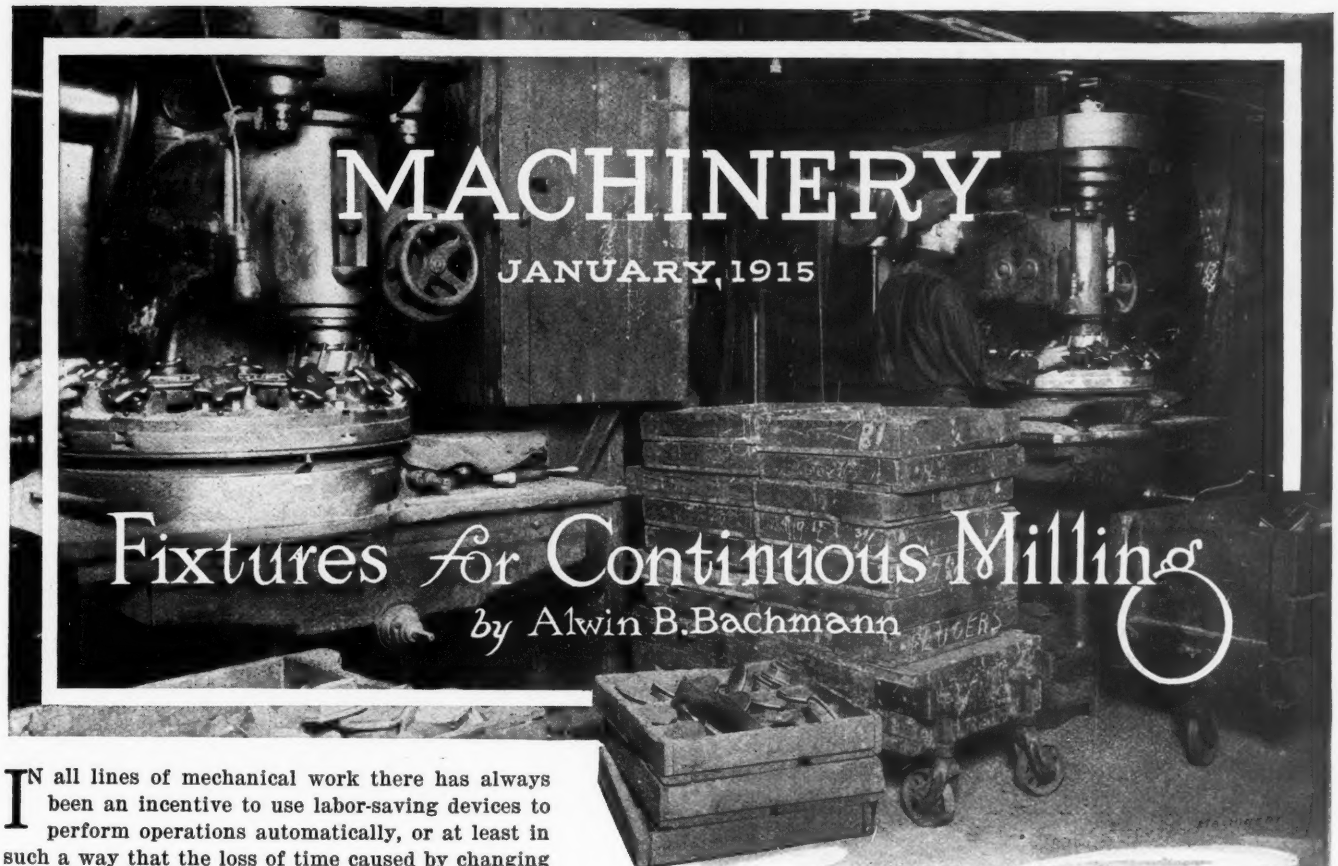

MACHINERY

JANUARY, 1915

Fixtures for Continuous Milling

by Alwin B. Bachmann

In all lines of mechanical work there has always been an incentive to use labor-saving devices to perform operations automatically, or at least in such a way that the loss of time caused by changing the work or tools is reduced to a minimum. The automobile industry has made wonderful progress in this direction, the use of a great variety of special tools and machines having been made necessary to meet the problems which have arisen in handling their work. The accompanying illustrations show a vertical milling machine and some of the fixtures with which it has been equipped to provide for the uninterrupted finishing of various classes of castings. The revolving table provides for passing the work continuously under the cutter so that the operator is only required to remove the finished pieces and substitute rough castings in their place. It will be evident that the output obtained in this way must be very satisfactory, as non-productive time resulting from the necessity of starting and stopping the machine, from the return movement of the table to the starting position, and from the exchange of finished work for fresh castings while the machine is at a standstill, is avoided.

The machine on which these fixtures are used is shown in Fig. 1; this is a special type of the Model C, high-power vertical milling machine made by the Becker Milling Machine Co., Hyde Park, Mass. The change made from the standard machine of this type consists of the elimination of the cross-feed and the provision of direct connection of the rotary table with the knee, thus insuring the utmost rigidity. Fig. 2 shows five different automobile parts which are to be milled on the faces marked *f*. Before entering upon a discussion of the method of machining these parts, it will be of interest to know the rate at which they were machined in continuous rotary milling fixtures used on the machine shown in Fig. 1. In a ten-hour day, this rate amounted to 1400 pieces of part No. I; 1200 pieces of part No. II; 2400 pieces of part No. III; 1800 pieces of part No. IV; and 2000 pieces of part No. V. These figures serve to emphasize the advantage of the continuous rotary milling process for handling work of this character, as the rigidity of the machine and fixtures insures the required degree of accuracy, while the rapidity with which the work can be handled enables a very satisfactory rate of production to be obtained. In most cases, the rate of production depends upon how fast the operator is able to replace the finished work by fresh castings, and as a result, care should be taken to make the action of the clamping mechanisms as rapid as possible. In addition to rapidity of operation, the design of the clamps must be such that they grip the work securely without any tendency to cramp or twist it; otherwise accurate results cannot be hoped for.

Fig. 3 shows the milling fixture for machining part No. I, set up on the rotary table of the milling machine, and Fig. 5 shows the design of this fixture. The L-shaped base *A* has fourteen equally spaced holes in its upright wall to receive the studs *B* on which the pieces to be milled are mounted. These pieces have previously had a hole bored in them and one side has also been faced square with the hole. Seven equally spaced uprights *C* are cast solid with the base and a hardened stop *D* against which the work rests is carried at the top of each of the uprights. There are also seven equally spaced brackets *E* which are screwed to the base of the fixture and carry the clamps which hold the work. By referring to Figs. 3 and 5, it will be evident that each clamp holds two pieces of work which are located between the clamp and the stops *D*. Provision is made to allow the clamps *F* to slide in order to compensate for variation in the castings, the slots in the clamps being covered by large headed bolts *H* which prevent chips from entering the slots. The clamps *F* and binder bolts *H* are held back from the work by springs *Q*, and in order to secure the work in the fixture, the swivel bolt *K* is swung up over the binder lever *I*, after which the nut *L* is turned down. This draws the clamp *F* down onto the two adjacent pieces of work which are located against the stops *D* in the correct position for milling. It will be seen that nuts *M* are threaded onto the ends of the studs *B* which carry the work, these nuts being employed to bring the finished face of the castings back against the locating faces *P* of the fixture. A split washer *O* holds the work in place, while the nut *M* is small enough so that the work can be drawn over it, thus making it necessary to merely loosen the nut in order to remove the work from the fixture. The engaging faces of the nut *M* and washer *N* are turned concave and convex respectively, the adjustment provided in this way taking care of any unevenness on the rough side of the casting.

The nut *M* and the wrench used for tightening it are one of the features of this fixture. This wrench is shown in the foreground in Fig. 3 and a better idea of its construction will be obtained by referring to Fig. 6, where it will be seen that three hardened pins are pressed into the body of the wrench. Half of each of these pins is sunk into the sleeve, which serves to back up the pins, while the other half of each pin enters the semi-cylindrical grooves formed in the nut. The ends of the studs *B* form pilots for the wrench so that it will slip

For additional information on rotary milling, see "Milling Sad Irons," in the November, 1912, number of MACHINERY.

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on easily. This form of nut and wrench makes it possible for engagement to be made in nine different positions so that the turning of the nut M can be effected very rapidly. When the fast movement of the rotary table is taken into consideration, this is a feature of great importance. In order to set the milling cutter at exactly the required distance from the center of the studs B, one of the stops D was adjusted on its top face to allow a ⅛-inch gage block to be used for this purpose. The fixture for machining part No. II is very similar in construction to the one which has just been described for machining part No. 1. This fixture is shown in Figs. 4 and 6 and will be readily understood by referring to those illustrations in connection with the preceding description.

Very close limits were required on the distance from the

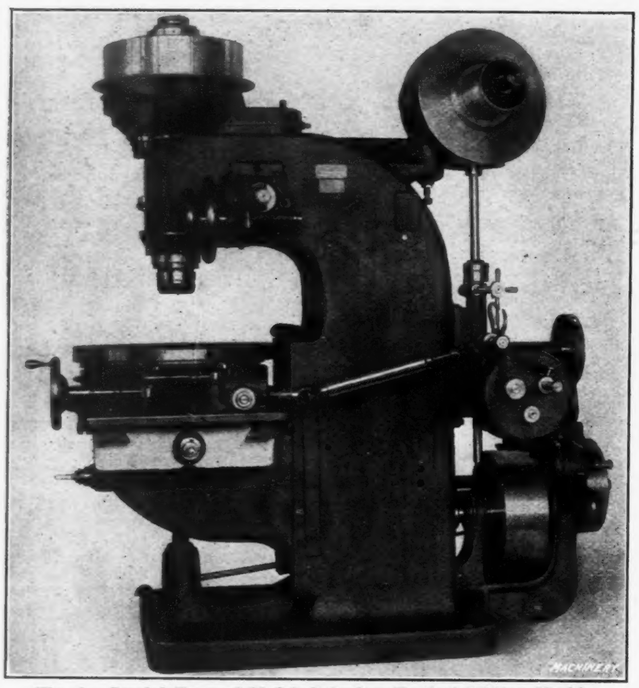

Fig. 1. Special Type of Model C Becker Vertical Milling Machine on which the Fixtures are used

center of the hole in the work to the face finished by the milling operation, and this made it necessary to take particular care to have all of the studs located in the fixture at exactly the same height. This result was obtained in the following manner: When finishing the stud holes, the base A of the fixture was set up on an auxiliary circular table which, in turn, was mounted on the table of a boring mill. Care was taken to have the circular table run absolutely true with the boring-bar and when this result had been obtained, the base A of the fixture was fastened to the auxiliary table and not removed until it had been completely finished. The auxiliary table was used for indexing, and the boring and facing operations were performed at one setting.

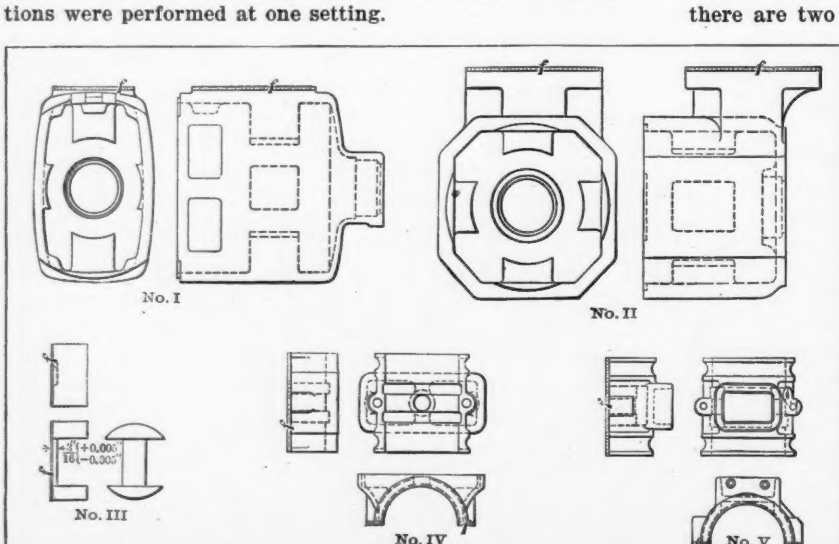

Fig. 2. Examples of Automobile Parts that have the Surfaces marked f machined on the Rotary Milling Fixtures

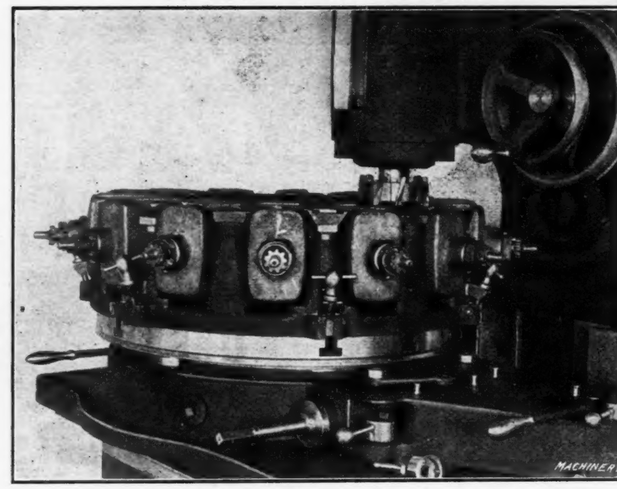

Fig. 3. Type of Fixture used for milling Part No. I in Fig. 2

A very delicate piece of work, so far as the provision of a clamping mechanism for holding it in the fixture is concerned, is part No. III in Fig. 2. It will be seen that the small center web is only 3/16 inch in thickness, and a comparatively light pressure such as might be brought to bear by squeezing the piece between the thumb and finger, is sufficient to spring it. Although the inside of the web remains rough, limits of ± 0.005 inch were required on the thickness; and in addition, the parallelism of the web is essential. Owing to these features of the work, the clamping mechanism had

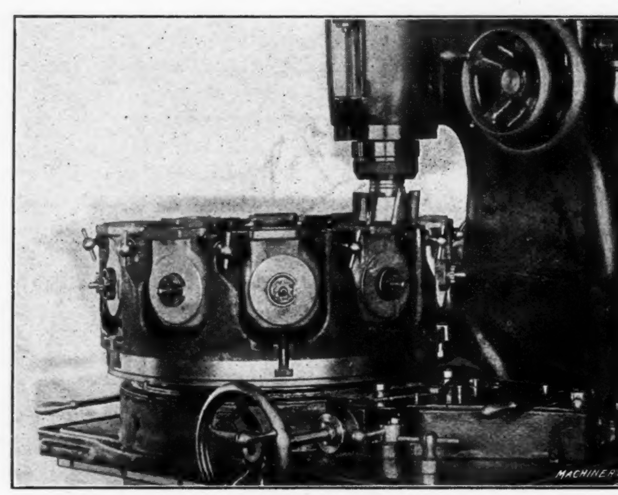

Fig. 4. Fixture used for milling Work of Form shown at No. II in Fig. 2

to be designed with provision for floating the work. The fixture used for machining these parts is shown in Figs. 7 and 8. Referring to these illustrations, it will be seen that there are two jaws E mounted in each of the rear blocks F and that two similar jaws are carried in the binder straps G, these jaws being loosely mounted in their seats. Springs H support the jaws, and this design enables them not only to adjust themselves to the shape of the work, but also to pull the work down into contact with the supporting block I when the clamps are tightened. In this way the parallelism of the web is assured. To provide the movement of the binder straps G, which is necessary to allow them to compensate automatically for variations in the width of the work, the binder straps rest on studs K which have semi-cylindrical upper ends. The holes in which these studs fit and also the holes for the binder screws L are large enough to provide the necessary play. The holes in the straps are concave and the convex washers M fit into them. In this way the tightening of the nuts O on the binder screws L enables the straps G to compensate for variations in the work. Two

spring plungers *N* support each binder strap when the clamp is released, to provide for removing a finished piece of work and substituting a fresh casting. The stop-pins *P* locate the work and take the end thrust when milling, thus relieving the floating parts of the clamping mechanism from strain.

The preceding paragraph described how the work was clamped without twisting it and how the desired parallelism of the center web was obtained at the same time. Another point which had to be taken into consideration was setting the pieces square. As the web has a convex surface on which it rests, a special attachment had to be provided for locating the work squarely in the fixture. This attachment is shown in Fig. 10. The baseplate *Q* which is fastened at the center of

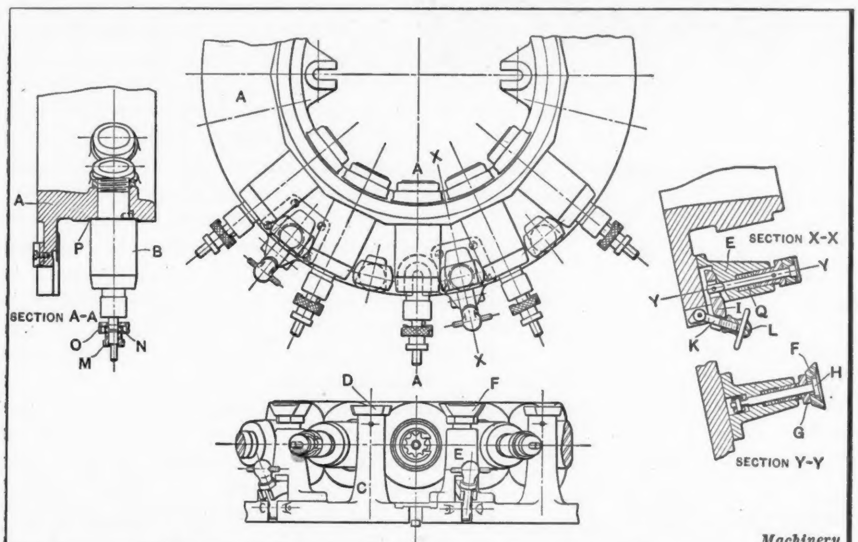

Fig. 5. Design of Rotary Milling Fixture shown in Fig. 3

the rotary table carries a stud *R* on which the arm *S* is pivoted. The plunger *T* has two ⅜-inch slots, the lower one of which receives the piece *U* which has three points that engage the work, while the lever *V* which operates the plunger passes through the upper slot. The member *U* cooperates with the jaws of the fixture in pulling the work down into contact with the supporting block *1* (Fig. 8) and when the work is set ready for clamping, the plunger *T* is pressed down by means of the lever *V* which is pivoted on the pin *W*. This serves to locate the work squarely in the fixture, after which the clamps are adjusted to hold it in position. To obtain just the right position of the plunger *T* over the work while the rotary table is in continuous movement, the rear end of the lever *V* enters slots in a dial *Z* which has the same number of slots as the number of pieces of work held in the fixture. The dial *Z* is set in such a relation to the clamps of the fixture, that the member *U* is brought down in the proper position to square the work preparatory to clamping. After the work has been properly squared up, the spring *Y* releases the lever *V* from the dial *Z* and lifts the plunger *T*, thus leaving the attachment free to be revolved to square up the next piece of work.

Figs. 11 and 12 show a fixture which may be adapted for machining the pieces Nos. IV and V in Fig. 2. Parts of the form referred to, but of two different sizes, had to be milled, and to provide for this work a single fixture was arranged for handling both sizes. Referring first to the sectional view through the fixture for part No. IV, it will be seen that V-blocks *D* made of

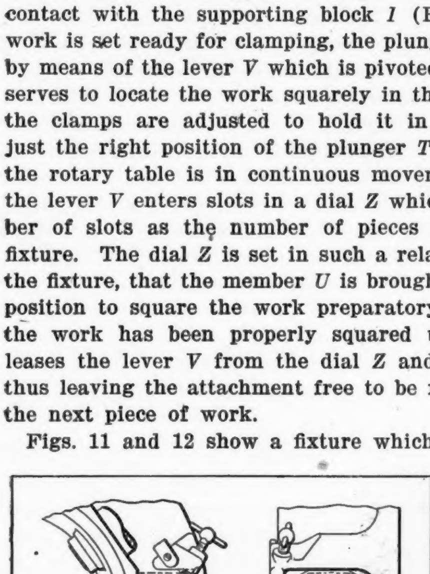

Fig. 6. Details of Fixture illustrated in Fig. 4

hardened steel are provided in which the work is supported. These V-blocks are made interchangeable with V-blocks of the proper size for holding the smaller pieces at a higher level in the fixture, so that the binder strap *E* can secure both sizes of work. The rocker *F* which is carried by the binder strap adjusts itself to the work and avoids any cramping action which would otherwise occur when fastening the work down. The thrust is taken up by the binder strap, the small pin *I* on which the rocker is pivoted merely serving to hold the rocker in the strap. Spring plungers *G* and studs *H* locate the work in the correct position for milling. When changing the work, the binder nut *K* carried by the swivel bolt *L* is swung out from the binder strap, after which the strap is swung back against the stop *M* so that the work can be removed from the fixture. The entire clamping mechanism is carried by a bracket *N*, there being eighteen of these brackets equally spaced around the base *O* of the fixture.

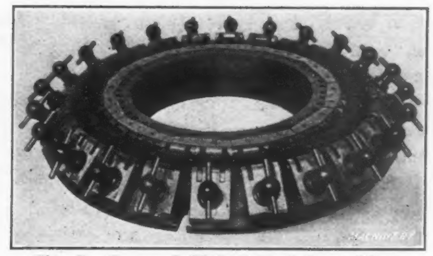

Fig. 7. Form of Fixture used for milling Piece No. III

Both sizes of part No. IV were the same shape so that the same form of locating members *G* and *H* could be employed. This is not the case with the two sizes of part No. V, and as a result a different arrangement had to be provided for locating the two sizes of work in the fixture ready for the milling operation. The binder

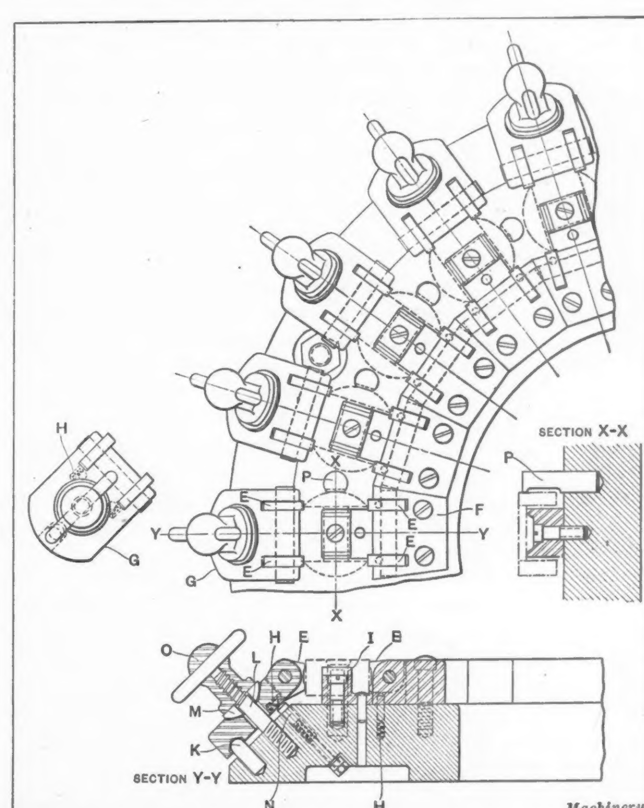

Fig. 8. Details of the Fixture shown in Fig. 7, illustrating Provision for supporting Thin Work

nut, swivel bolt and binder strap are the same as in the fixture for machining part IV, but instead of using interchangeable steel V-blocks, interchangeable cast-iron blocks *P* were screwed to brackets *Q* as shown in the cross-sectional view in Fig. 11. Each of the blocks *P* carries its own locating members; those for the smaller work are not shown,

but consist of a spring plunger *G* and locating pin *H* as shown in the cross-section of the fixture for part IV. Those for the larger work are clearly shown in the cross-section on the line *Z–Z*, where it will be seen that two studs *R* and *S* are mounted in the block *P*. The stud *S* is slotted and carries a small rocker *V* which locates the work against the stud *R* through the action of a spring plunger. The blocks *P* are made of cast iron and the V-shaped recess in which the work is held is lined with hardened steel strips *U* to provide a durable bearing for the work.

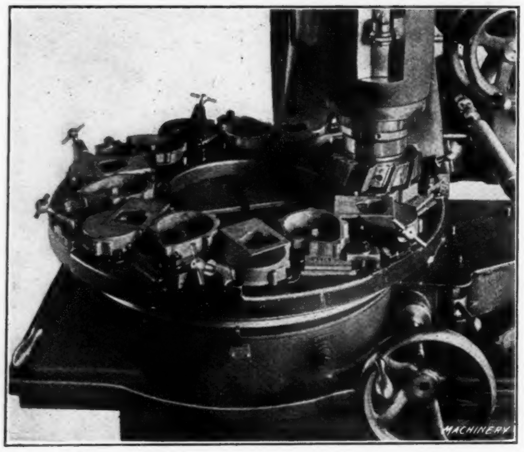

Fig. 9. Fixture for Use in milling more than One Face on the Work

In order to design efficient and durable fixtures for continuous rotary milling, the following points are worthy of particular attention. The pieces to be milled should be placed as close together as possible to avoid time lost in traversing the cutter from piece to piece. When the shape of the work permits of it, the circle in which the pieces are arranged should be as small as possible, as the output is not dependent upon the number of pieces which the fixture holds but upon the rate at which the work is fed to the cutter, which is independent of the diameter of the fixture. It will be obvious, however, that the cost of the fixture will be reduced in proportion to the diameter of the circle on which the work is arranged. Fixtures should never be designed along lines which make it impossible for the operator to change the work as rapidly as the table revolves. They should be designed to take all the different sizes in which a part of a given form is made or even different parts of similar shape.

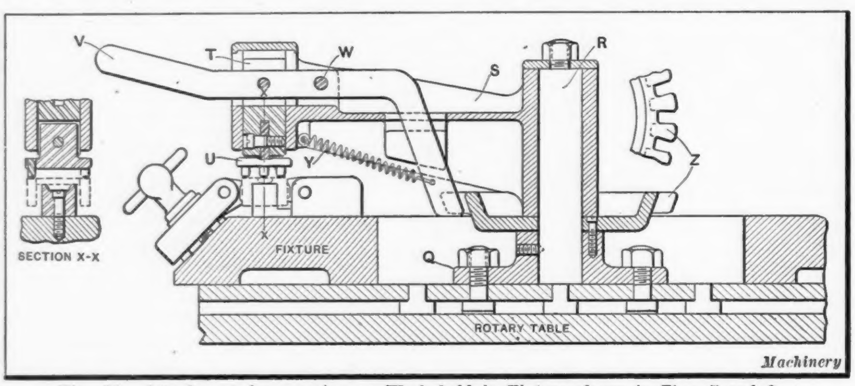

Fig. 10. Attachment for squaring up Work held in Fixture shown in Figs. 7 and 8

Fixtures for handling work which has to be milled on more than one side can often be arranged to take care of all of the different milling operations, an excellent example of a simple and efficient fixture of this kind being shown in Fig. 9. The gear housings for a certain automobile starter have to be finished on two sides and the fixture shown in this illustration holds fourteen pieces, seven of which are arranged in equally spaced stations where the first operation is performed, this operation consisting of milling the square base. In performing this operation, the rough casting rests on three hardened pins. The other seven castings on which the second operation is to be performed are set between those on which the first milling is done. The second set of castings is located by a finished spot which is the same distance above the pins that support the rough castings as the depth of the cut taken on the second operation. The work is changed in the following manner: A casting which has been finished on both sides is removed and replaced by the adjacent casting on which the first operation has been performed; and the partially finished piece is replaced by a rough casting. The advantage of this arrangement consists not only of having two fixtures combined in one, but also of being able to finish seven pieces on both sides for each revolution of the rotary table. When machined in this way, the amount of handling required by the work is reduced to a minimum. In connection with this fixture the advantage of having the work located close together in order to reduce time lost in traversing from piece to piece is clearly demonstrated. When machining parts in large quantities, continuous rotary milling will be found the method of maximum efficiency in practically all cases where it can be employed, and as a result it should be adopted wherever possible. The advantages of handling work by this method are so great, however, that it will often be found worth while in cases where the quantity of work to be machined is not very large.

* * *

It has been known for several years that liquid oxygen mixed with a substance like cotton-wool forms a powerful explosive. In the past, however, there have been serious difficulties encountered in its practical use, but it is claimed that a new method has been discovered for handling oxygen so that it can be used commercially as an explosive. It is stated that bags which are filled with a special form of lamp black soaked in liquid oxygen for a few minutes just before they are required for use will, if detonated, explode with the force of dynamite at a cost much less than that of the latter explosive. There is no danger from a mis-fire, as the oxygen will evaporate in a short time, and a lighted match may be put to the charge and cause only a quiet, slow burning of the charge.

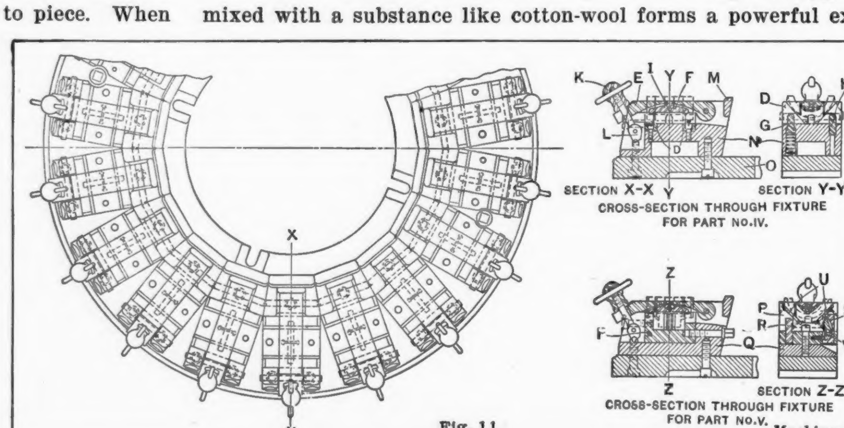

Fig. 11. Design of Fixture shown in Fig. 12 and Jaws for holding Work IV and V

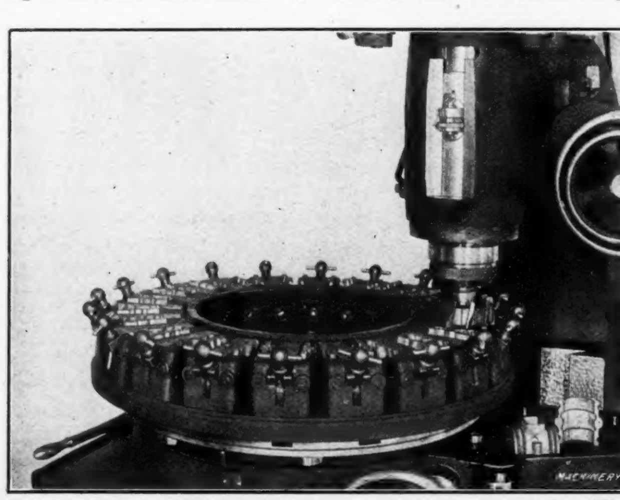

Fig. 12. Fixture of Type used for milling Parts Nos. IV and V in Fig. 2

COMPENSATING AND QUICK-ACTING CLAMPING DEVICES*

DEVICES USED IN UP-TO-DATE MANUFACTURING TO INSURE RAPID PRODUCTION AND COMMERCIAL ACCURACY

BY ALBERT A. DOWD†

THE manufacturer of the present day is looking for maximum efficiency in his methods of production, and with this in view he endeavors to take advantage of every improvement in machine tools that will help to increase his output. In the work of the factory, modern improvements of all kinds are used to facilitate the rapid handling of parts and their transfer from one department to another. The "tooling" for the various machine tools is much more carefully studied than it was a few years ago, so that the greatest possible output of the machine can be attained, and fixtures for holding the work during the process of machining are much more carefully designed, so that as little time as possible will be lost in locating and clamping the work.

In horizontal and vertical turret lathe work the development of fixtures and holding devices is very noticeable. In the design and construction of quick-acting clamping devices for turret lathe fixtures, there are several important points to be considered:

1. Quick and accurate location for the work that will not be subject to variations caused by the presence of dirt or chips.

2. Arrangement of fixture in such a way that locating points or surfaces can be kept in their proper relation, so that the desired accuracy may be maintained at all times. Provision should be made for wear or breakage, either by a construction that will permit replacement, or a method that will allow the adjustment of the points in question.

* For supplementary material on clamping devices, see "Clamping Work in Jigs," MACHINERY, December, 1913.
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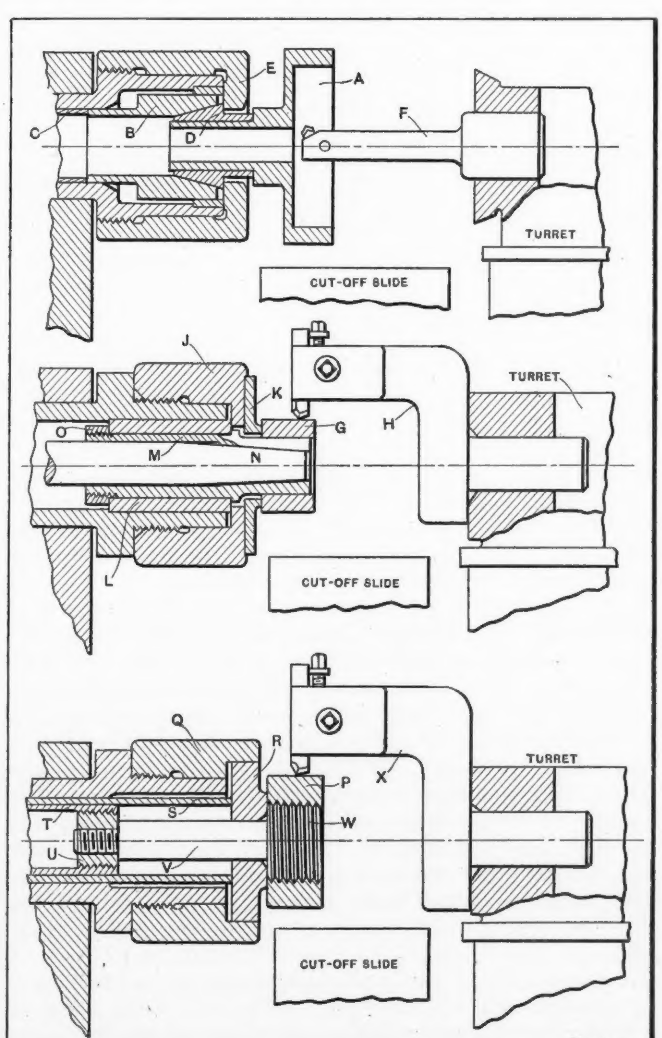

Fig. 1. Collet Mechanisms

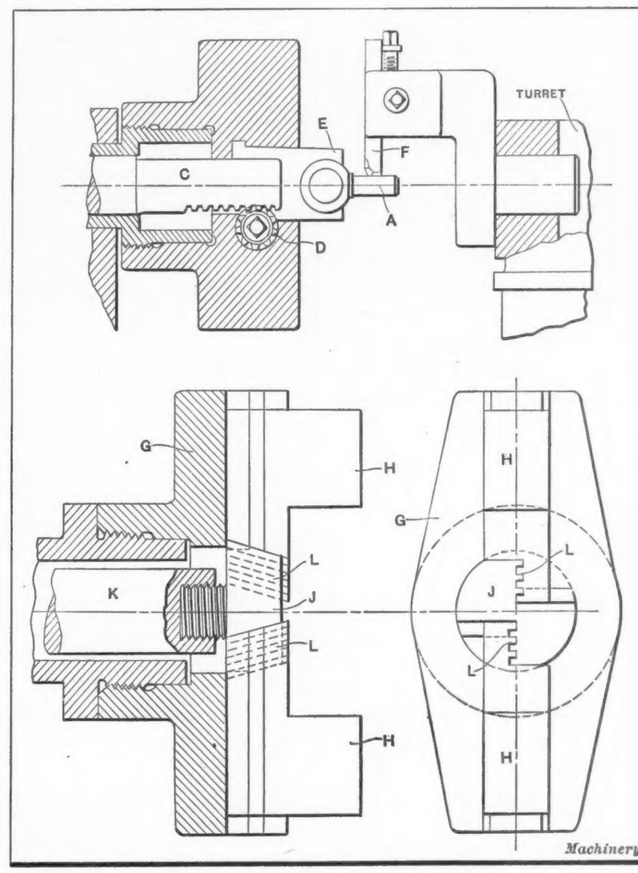

Fig. 2. Quick-acting Two-jaw Chucks

3. Precaution in designing so that distortion of the work will not take place because of improper clamping or faulty locating. Care must be taken so that too much force will not be applied to the screws or other devices used in securing the work, and attention must also be given to the possibility of "cocking" the casting by a faulty application of the clamps.

4. Provision for compensating for unequal pressures that might result when several clamps are to be operated from a common point, for unless this matter is properly taken into consideration the clamps will not hold securely. When clamps are to be set up on a rough casting, special attention must be given to this feature of the design, so that the holding action will be positive and secure.

5. Provision for incorporating a "driver" whenever possible, as the strains incident to the cutting action of the tools are taken by it to a great extent so that the clamps are relieved. Chances for distortion are minimized, and the clamps need not be set up so tightly if a driver is provided.

A number of examples of quick-acting clamps and compensating devices for horizontal and vertical turret lathe fixtures are described in the following and important points in construction and design will be noted.

Quick-acting Clamping Devices

The three-jawed universal chuck is undoubtedly the most familiar form of rapid clamping device. Its use, however, is limited to cylindrical work or that of a semi-cylindrical nature, when used with the standard equipment of jaws. For second-operation work soft jaws are frequently used, these being bored out on the machine to the size of the finished work. The step-chuck is another example of a quick-clamping device.

Various forms of collet mechanisms may also be classed among the examples of quick-clamping devices. Some of the variations and developments of these devices are of sufficient importance to be included with the other forms described here. The majority of collet mechanisms on the horizontal

type of turret lathes are operated from the rear end of the spindle by means of a hand lever which controls the longitudinal movement of an internal sliding sleeve. This sleeve operates the closing mechanism when arranged for normal work.

Fig. 1 illustrates three developments of collet closing mechanisms adapted to several classes of work. The upper view represents the device when used under normal conditions, the work *A* having been partially machined in a previous operation. The regular collet chuck or nose-piece *E* is screwed to the spindle and serves to keep the parts in position and also to prevent longitudinal movement of the jaws *D* when the closer *B* is forced forward by the operating sleeve *C*. This type of mechanism is supplied with Pratt & Whitney turret lathes, and is especially desirable for second-operation work, as the longitudinal location of the work is positive on account of the absence of a longitudinal movement of the jaws. A boring-bar *F* is shown in the turret.

The central figure in the illustration shows an expanding collet made by the Garvin Machine Co. for use with turret lathes. The work *G* is to be turned and faced by the turning tool *H* and a facing tool mounted on the cut-off slide. A special nose-piece *J* is screwed onto the spindle and holds the locating sleeve *L* in position. Through this locating sleeve the split collet *M* passes, held securely by the nut *O* at the inner end. The operating rod *N* is connected to the regular operating sleeve and is tapered at the forward end to fit the taper of the expanding collet. The action of the device is very satisfactory for second-operation work, and it may be manipulated rapidly. There is no end movement of the mechanism.

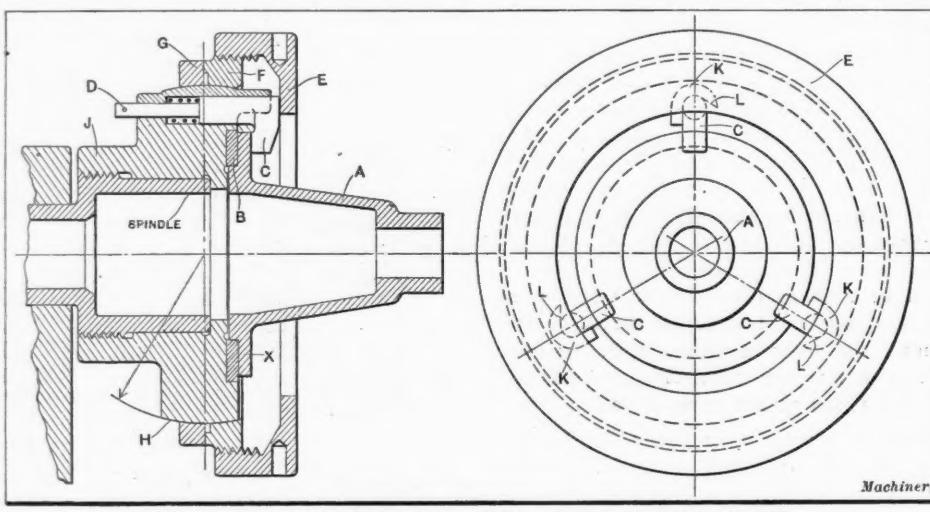

Fig. 3. Quick-acting Compensating Holding Device for Automobile Hub

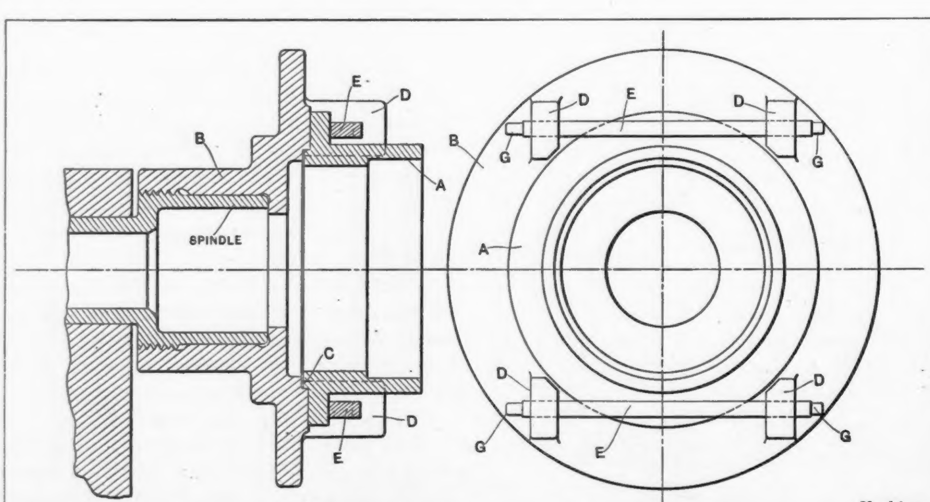

Fig. 4. Quick-acting Clamping Fixture in which Wedges are used

The lower figure shows an adaptation of the collet mechanism to a piece of threaded work *P* which is to be turned by the turning tool *X* and faced by the cut-off slide, square with the threaded portion. The nose-piece *Q* is screwed to the end of the spindle. A movable collar *R* is fitted to the end of the nose-piece and is controlled longitudinally by operating sleeve *S*. The threaded arbor *W* is screwed into a fixed internal sleeve *T*, the connection being made through the threaded collar *U*, the stem *V* of the arbor being a running fit in the movable collar *R*. It will be noted that the clamping action takes place when the sleeve is moved forward, and the release is effected by a reversal of the operation, no end movement of the work being evident. An arrangement of this sort is very useful for threaded work and its operation is sufficiently rapid to satisfy the most exacting requirements.

Quick-operating Two-jawed Chucks

Chucks of the two-jawed variety are occasionally fitted with devices for rapidly opening and closing the jaws, two of these mechanisms being shown in Fig. 2. The upper illustration shows a Pratt & Whitney two-jawed chuck in which the jaws *E* have been formed to receive the brass key *A*, the turning operation on the work being performed by the tool *F*. The jaws of this chuck are normally operated by a right- and left-hand screw on the shaft *D*, which passes through the chuck. In this instance, the shaft is fitted with a piston in the center, between the two jaws. This pinion is revolved by a rack cut on the operating rod *C*, the longitudinal movement of which is obtained by a special arrangement of the collet closing mechanism at the rear end of the spindle. The regular sleeve and the fingers that operate it are removed, and a collar is placed on the rod which allows a coupling to be made with the lever that normally operates the mechanism. As the pinion is revolved, the jaws open or close according to the movement of the rod.

The Garvin Machine Co. manufactures a two-jawed chuck designed especially for rapid operation through the collet mechanism. The lower view in the illustration shows the arrangement used. The chuck body is screwed onto the spindle in the usual manner, and in it are mounted the two jaws *H*. These jaws are manufactured in several styles for either external or internal work and with or without inserts. Either compressed air or spring pressure may be used to operate the mechanism, and the movements are controlled by the foot of the operator on a treadle beneath the machine, so that his hands are left free to handle the work to the best advantage. The jaws are provided with multiple wedge surfaces *L* that mesh with corresponding angular grooves in the central plug *J*, this plug being screwed into the operating rod *K* which is spring-controlled in one direction and treadle-controlled in the other. The maximum movement obtainable is about 3/16 inch on each side, which is ample to take care of practically any condition that may be encountered. When reversible jaws are used, the change from external to internal holding only requires a reversal of the jaws and an extra center wedge plug, the change from one type to the other being accomplished in a few minutes.

Quick-acting Compensating Holding Device for Automobile Hub

The automobile hub *A* in Fig. 3 had been partially machined in a previous operation. The outside taper and the end of the hub were to be machined in the setting shown, the tapered surface being machined by a taper attachment. There were

a large number of these pieces, so that the expense of the fixtures was a minor item when compared with the output desired. Six machines were needed to produce the required quantity, these machines being horizontal turret lathes with special tooling and holding devices of the type shown in the illustration.

Both tooling and fixtures were designed with a view to increasing the production. The usual method of clamping the work by means of three or more straps or hook-bolts and setting up each one of these separately with a wrench was considered too slow, so it became necessary to devise a method by which all clamps could be tightened simultaneously and with a uniform pressure.

The work *A* was located at *B* on a hardened and ground steel locating ring and was clamped in position by three hook-bolts *C*, bearing against flange *X*, which had been finished in the previous setting of the work. These hook-bolts were backed up by lugs *K* on the body casting, and the lugs themselves were cut away on one side as shown at *L*, so that the hook-bolts could be turned around part way in order to insert the work. A portion of the body *H* was turned spherical, and the steel pieces *G* and *F* were machined to a running fit on the spherical surface. Before machining the spherical portion of these two pieces, they were "papered up" with several thicknesses of paper so as to provide a "take-up" for wear. Piece *F* was provided with a thread that engaged with the threaded portion of the adjusting collar *E*. This collar was furnished with a series of holes around its periphery, in which a piece of drill-rod was inserted when clamping or releasing the work. It will be noted that the hook-bolts extend entirely through the body casting *J* and are forced outward by the coil springs, while the pins *D* limit the movement and prevent their falling out. A compensating action is obtained by the spherical bearing *H* on which the floating collar composed of the two pieces *G* and *F* is free to swivel. Slight inequalities and variations in machining are therefore equalized; the pressure of the hook-bolts is uniform, and there is no tendency to "cock" or distort the work. The operation of the device was satisfactory and its action as rapid as could be desired. The provision for "take-up" in the spherical ring and the ease with which a new locating ring *B* can be fitted are valuable features.

Quick-acting Clamping Fixture Using Wedges

Another quick-acting clamping fixture for the horizontal type of turret lathe is shown in Fig. 4, but this fixture is open to several objections which will be noted later. As in the former instance, the work has been partially machined in a previous setting and is located in the fixture by surface *C*. No provision has been made for replacement in case of wear on the locating surface, it being the theory of the designer that when the surface became so worn as to produce inaccuracies in the product, it would be a very easy matter to cut a recess in the body casting at *C* and insert a steel ring. It was the expectation of the designer that the locating surface would remain in good condition long enough to complete the output required. This is questionable practice and should be discouraged unless the production is so small that there is little likelihood of inaccuracies resulting from it.

The body of the fixture is screwed to the spindle in the usual manner and is provided with four lugs *D*, slotted to receive the tapered clamping wedges *E*. These wedges bear against the flanged portion of the casting *A*, and are driven into their positions by a babbitt hammer. The ends *G* are relieved so that they will not become battered up in case the operator uses a steel hammer in place of a babbitt one. The wedges on this fixture are loose pieces and must be taken out when the work is completed. Care is necessary in replacing them to see that the proper side of the wedges bears against the work, and in addition to this, they must be driven in with about the same amount of force. Both of these features show a lack of care in the design, so that although the fixture may be rapidly operated, it should be considered an example of faulty construction. The lack of any method of compensating for or equalizing the pressure of the wedges may produce faulty locating and a possible tendency to "cock" the casting.

Combination Chucking and Clamping Device for an Eccentric Ring Pot

The arrangement shown in Fig. 5 is exceptional and appears complicated at first glance; but in reality it is comparatively simple, as it is merely an adaptation of a standard chuck to a somewhat unusual condition. There were approximately 10,000 pots of this kind to be turned eccentric, bored and cut off into narrow piston rings. No change in the design of the pot was permissible, as there were a great many castings on hand. An eccentric turning device operated simultaneously with the boring tool, and the rings were cut off by a gang of tools on the cut-off slide. Three machines were equipped for this work and the production of 4-inch rings averaged about 80 per hour, turned eccentric, bored and cut off.

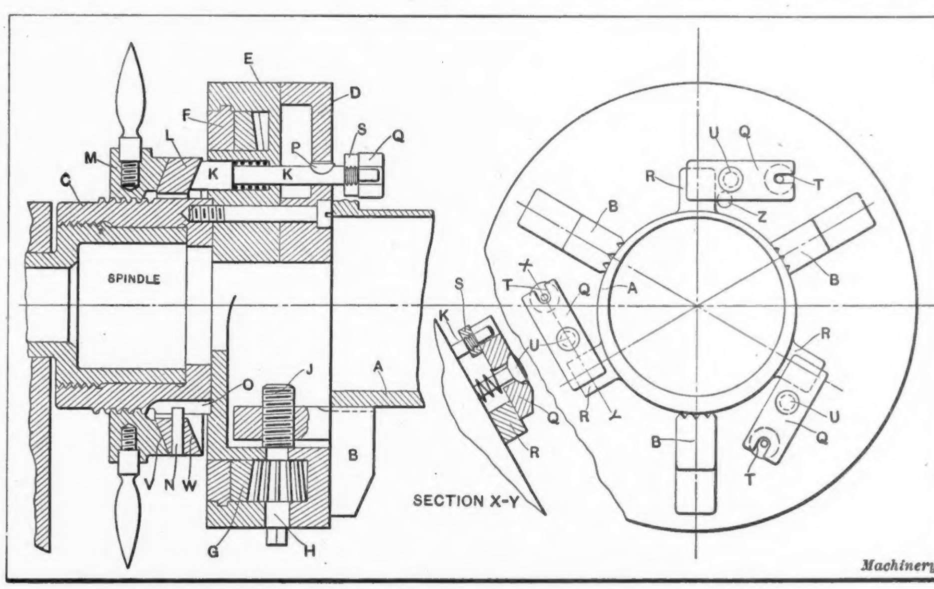

Fig. 5. Combination Chucking and Clamping Device used in making Piston Rings

The type of chuck used was a Pratt & Whitney combination, and the machine a horizontal turret lathe. This may be used as a universal or independent chuck, and for either concentric or eccentric work. When used as a universal chuck for eccentric work, as in the instance here given, the plate *F* at the back is unscrewed until the gear ring *G* is out of mesh with the operating pinions *H*. The jaws are then set independently by means of the screws *J* to conform to the eccentricity of the casting *A*, after which the back-plate is returned to its original position and the operating gear again meshed with the pinions. The chuck jaws will now operate universally, but the jaws *B* will be eccentric so that they will center the work properly. It will be readily seen that it would be impracticable to use the jaws for gripping the work with sufficient pressure to drive and hold it securely, so a method of clamping in addition to the jaws was found necessary. A pin driver *Z* was set in the face of the chuck plate *D*, and proved sufficient for this purpose.

The chuck is mounted on a special faceplate *C*, screwed to the spindle, and is threaded to fit the operating spider collar *M*. The front surface of this collar has a spherical seat *V* to fit the rear of the floating collar *L*. A pin *N* enters the slot *O* in the faceplate and prevents the floating collar from revolving. The surface *W* at the front of the collar bears against the ends of the three pins *K* that pass entirely through the chuck and are keyed at *P* to prevent turning. These pins are kept firmly against the floating collar by coil springs, and their outer ends are furnished with thrust collars *S* that lift the ends of clamps *Q*, thus causing them to pivot on the ball-

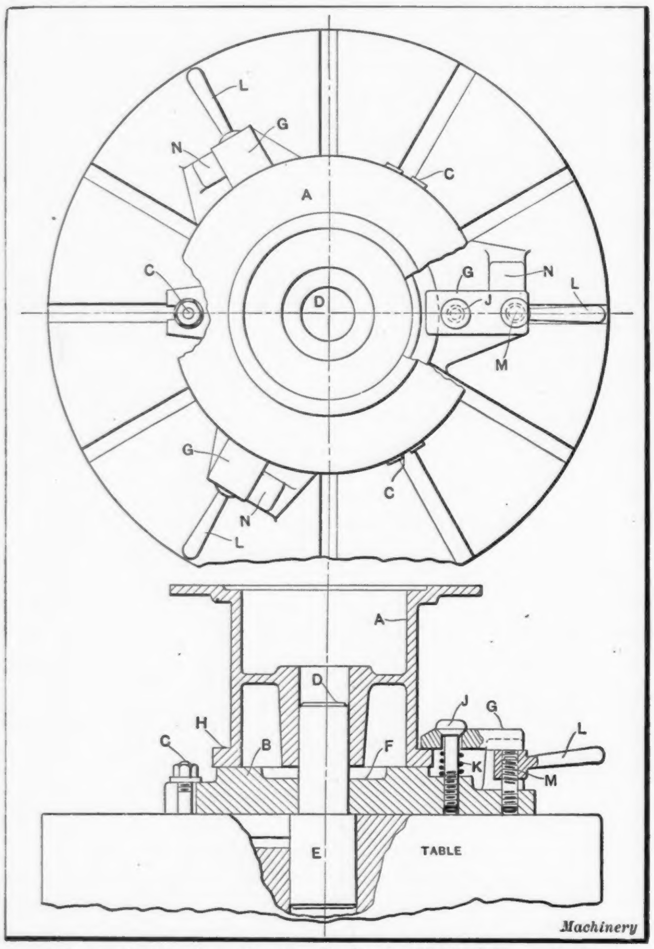

Fig. 6. Quick-acting Clamping Device for Vertical Turret Lathe

headed screws U and therefore depressing the other ends which grip the three lugs R on the pot casting. The slots T at the ends of the clamps prevent them from becoming displaced during their operation. The small section X–Y clearly shows the construction of this portion of the clamping arrangement. It will be noted that when the spider collar M is revolved, the spherical bearings V and W allow a compensating action of the pins K, which thereby equalizes the pressure on all three of the clamps Q. The action of this entire device was rapid and the work obtained by its use satisfactory.

Fixtures for the Vertical Turret Lathe

In the design of fixtures for the vertical turret lathe more power is usually required in the clamping devices, the amount of stock to be removed usually being greater and the feeds employed considerably heavier. For these reasons it is always well to make use of a driver whenever this is possible. If the construction does not permit the use of a driver, the area of clamping surface should be as large as is consistent with the design, and the clamps should be especially powerful so as to obtain as great a degree of friction as possible without distorting the work.

The work A shown in Fig. 6 has been previously machined both in the small hole and on the face of the smaller frame and hub. In this instance, on account of the comparatively small number of pieces to be machined, it was not considered advisable to go to the expense of making a fixture with a compensating device for clamping. Rapidity of operation, however, being highly desirable, it was decided to make quick-acting clamps without the compensating features. No driver could be employed.

In the fixture, the work is located on the central stud D which extends down through the fixture and centers it on the table by the larger end E fitting into the center hole. The fixture itself is clamped in position by three bolts C. The finished face of the flange H rests on the annular pad B. Three clamps G are arranged around the flange and are set up tight against it by the action of the lever L which is threaded with a double thread at M. The ball-ended stud J allows the clamp to tip or rock sufficiently to gain a good bearing on the flange. The lugs N take the thrust of the tail of the clamp. It will be noted that the operator can readily tighten two of the clamps at once, one with each hand, so that the action of the device is very rapid.

Internal Equalizing Device with Hook-bolts

The work A in Fig. 7 has been partially machined in the previous operation and is located for this setting on a hardened and ground steel ring by the shoulder E. The fixture B is located on the table by the center stud J and held down by three bolts H. Before the work comes to the vertical turret lathe for this setting, the flange is jig-drilled with the six holes shown; one of these holes is used to assist in driving the work, the pin G being used as a driver. There are three hook-bolts L, spaced at equal distances around the inside of the flange, and kept away from it when they are not in use by the coil springs indicated. These hook-bolts are well backed up by the body of the fixture M. A reference to the upper view will show the manner in which the body is cut away at R to allow the hook-bolts to swing clear of the work. The upper end of stud J is threaded with a coarse thread at K. The nut O has a spherical bearing on the clamping collar N and the latter also has a spherical bearing on the ends of the hook-bolts. The pin S prevents the collar N from revolving when nut O is tightened. A special socket wrench P is provided with this fixture, the handle Q being long enough to give a good leverage. It will be noted that the pressure required on the hook-bolts in this fixture is not as great as it would be were there no driver, as pin G takes most of the strain. When nut O is tightened by means of the socket wrench, the spherical bearings, both on the nut and collar, permit the hook-bolts to adjust themselves to the variations in the casting, so that a positive compensating action is assured and the pressure is equalized.

Compensating Clamping Device for a Large Flange

The work A in Fig. 8 has been partially machined in a

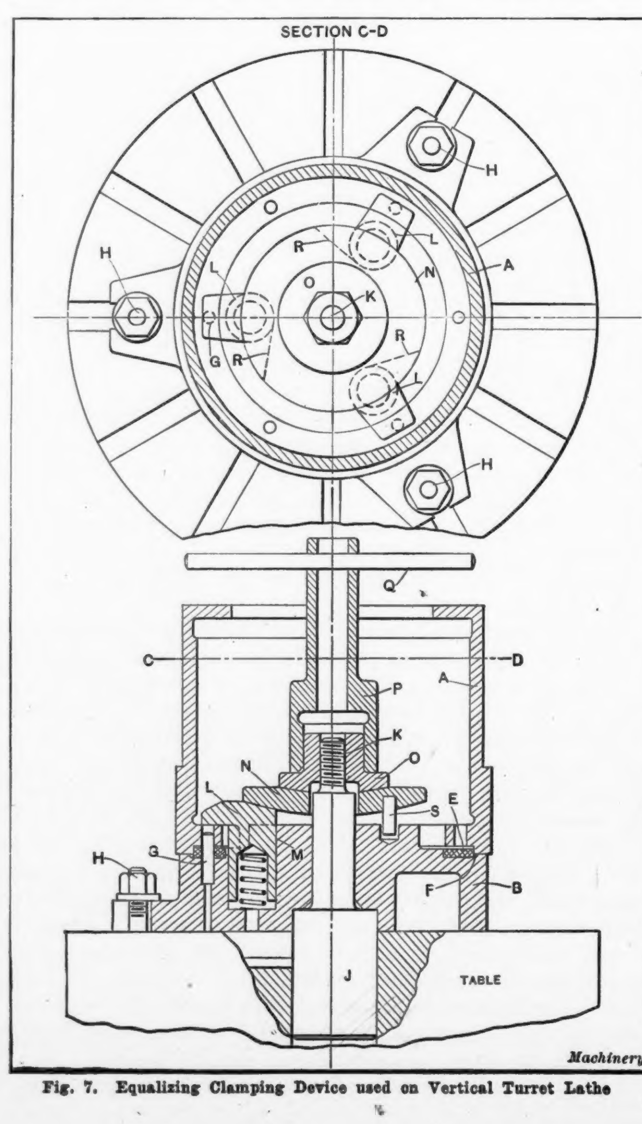

Fig. 7. Equalizing Clamping Device used on Vertical Turret Lathe

previous setting and the shoulder *B* is used to locate from, in the setting shown. After the first setting, and previous to that illustrated, the flange is drilled at *X* for a driver. The amount of stock to be removed during this operation is considerable, and unless a driver were provided, some difficulty might be experienced in holding the piece securely against the pressure of the cut. The fixture body *H* is centered on the table by the stud *F* which enters the center hole in the table at *G*. Three screws *C*, provided with shoes *D* at their lower end, enter the table T-slots. There are three clamps *E* spaced equidistantly around the flange and held clear of it when not in action by the coil springs below. The ball-ended screws *P* permit a rocking action to the clamps, so that they will adapt themselves readily to the surface.

Ring *L* is spherical on its lower side to correspond with the clamping ring *K* and is prevented from revolving by pin-driver *N* in the body of the fixture. This pin enters a slot *O* in the annular ring, the slot being large enough to permit of a slight rocking action without interference. The outside of the fixture is threaded at *J* and on it is mounted the clamping ring *K*. There are twelve holes *M* around the periphery of this ring for a long piece of drill rod by which the ring is revolved. This ring forces the ring *L* against the under side of clamps *E* and these swivel on the ball-ended screws *P* until they bear against the upper side of the flange and draw the work down firmly onto the fixture. As ring *L* is free to float on its spherical lower surface, it follows that an equalizing action is set up between the ring and the clamps, so that the pressure is distributed equally.

Equalizing Clamping Fixture for Steel Sprocket Gear

The steel sprocket gear *A* in Fig. 9 has been machined on one side and the hole bored in a previous operation. The shoulder *B*, the important locating surface, is used to set up the piece for this operation. The fixture *C* is provided with a center stud *E* that fits the center hole in the table at *F*. The fixture is clamped in position on the table by bolts *D*. As in a previous instance, clamps *G* are allowed to swivel on the ball-ended screws *H* and a coil spring underneath the clamps keeps them out of contact with the work when not in use. The large screw plug *M* is threaded into the body of the fixture with a coarse left-hand thread, and has a stem that extends upward through the collar *L*, and is squared at its upper end to receive a wrench. Collar *L* is formed spherically on its lower surface to fit a corresponding part on the screw plug *M*, and it has a bearing against the under sides of the three clamps shown. In order to prevent its revolution, a driving pin *J* is driven into one side of the collar and enters the slot *K* provided for it in the body of the fixture, sufficient freedom being given so that no interferences will take place on account of the rocking action of the collar.

After the work had been set in place on its locating shoulder *B*, the clamps are swung around in the position shown and a wrench applied to stud *N*. As the screw rises in the threaded pocket, collar *L* rocks on its spherical bearing and forces clamp *G* down onto the work with an equal pressure.

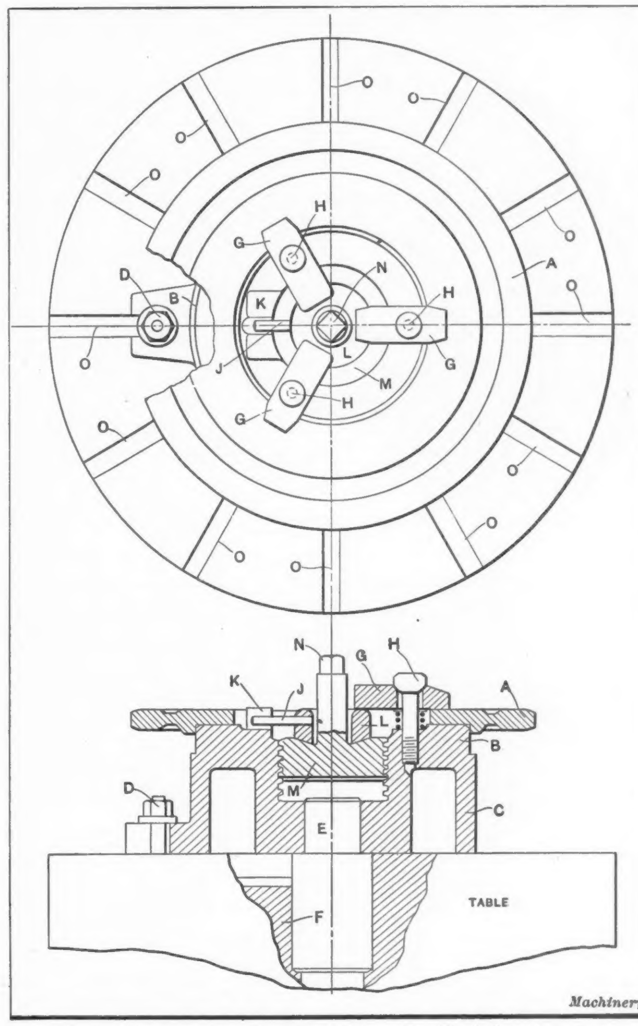

Fig. 9. Compensating Clamping Fixture for Steel Sprocket Gear

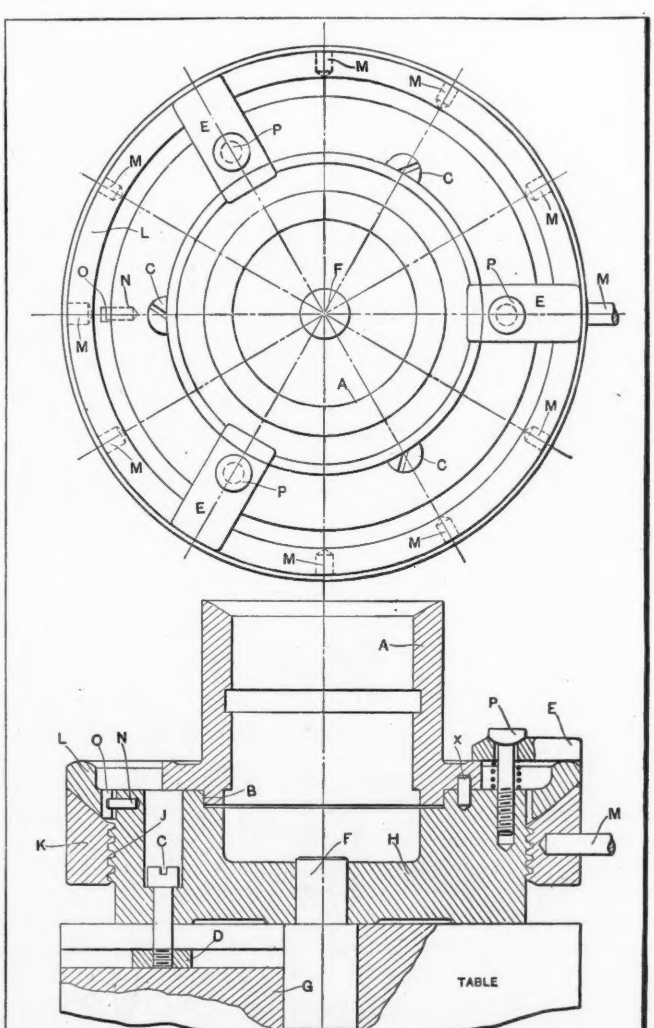

Fig. 8. Another Example of Equalizing Clamping Fixture used on Vertical Turret Lathe

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Small geared grinding machines have come into general use during the past few years on the farm, in small shops, in the kitchen and on repair work for sharpening tools. These machines, provided with artificial or natural abrasive wheels, are capable of sharpening tools quickly and effectively. The workman can hold the tool in one hand while he turns the crank with the other, and thus these portable machines economize time and labor, making unnecessary frequent trips to a stationary grinder or the employment of another workman to turn a grindstone. The classes of workmen benefited by these small grinding conveniences are legion, comprising practically every type of worker, such as carpenters, plumbers, blacksmiths, stone workers, masons, machinists, farmers, miners, garage workers, section men, etc.

STORY OF THE COMBINATION SQUARE

BY L. S. STARRETT*†

L. S. Starrett

In 1876, while making patterns, I was impressed with the need of improvements in try-squares to fill the place of a kit with different lengths of fixed blades for patternmakers' and carpenters' use on various grades of work. The idea of a sliding blade struck me as the right principle to work on. After I conceived the design I made patterns, got castings and a blade and had the first sample made by a good machinist, who, not believing in an adjustable square blade, said he "wouldn't give a damn for it." But that did not discourage me. I showed it to Samuel Colt of Hartford, the noted revolver manufacturer. He grabbed it out of my hands and exclaimed: "That is a good thing. That will sell. Did you get it up? I want one."

He being a man after my own heart this was encouraging. I made a contract with a Connecticut company who made old-style try-squares, etc., to make 5000 as a starter. After awhile I got the first lot and showed them to the hardware men, all of whom admitted it to be a good thing, but said that as it was not introduced there was no demand. They said: "If you will get them introduced, we will buy them." I saw the point. So I employed agents, giving them a generous commission to canvass the manufacturers and sell direct to employes, in many cases taking orders to be delivered after the next pay-day. The squares sold like hot cakes, and so my agents did well for themselves and well for me. But I could not get them made fast enough to fill orders.

My first one-sheet circular headed by a cut of the combination square gave the following description: "The old-style try-square superseded by an instrument that is more than a substitute for a whole kit, from the shortest to the full length of blade, and more convenient than a whole kit can be. It is also a miter square, a plumb and level, a depth and mortise gage, a steel rule and straightedge, a scriber or scratch gage, and a gage for transferring measurements." When this circular was shown to the manager of the concern I had contracted with he exclaimed: "No, you don't! No, you don't!" meaning superseding the old-fashioned try-square, being somewhat jealous, you see. How much this had to do with my not getting the squares as fast as I wanted I don't know, but being a good friend to the foreman I interested him in pushing things to get out a lot on time. The management could not understand why their foreman was so intensely interested in getting the work along as fast as he did.

However, as the work was not as good as I wanted, I fitted up a small shop in Athol and started to make them myself, hiring the best workmen I could find. But to get the blades graduated was what bothered me most. I tried to place a contract with a firm making scales but was turned down. I could not buy a graduating machine for love nor money. So after deciding on the best method of graduating I got hold of an idea and perfected my own machines and system, and not only made and graduated my square blades, but put on the market an improved line of spring-tempered steel rules that are now acknowledged and accepted as standard the world over. Among the first scales I made was a "very-thin scale." I christened this "flexible" to distinguish it from the heavier spring-tempered scale. This has since been copied by all of our competitors who make scales.

Soon after I put out my squares I added a center head to slip off and onto the same blade to use in finding the center of circular work; also a bevel protractor to use with the same blade, all of which have added much to the value of the tool, and since my patents have expired these tools have been copied at home and abroad by many of our competitors who no doubt think imitation is no crime.

It may be of interest to state that it was not long after my introducing agents got to work that the hardware dealers made inquiries with the intention of placing orders. As my agents at that time were selling all I could produce they were informed that I was not ready to sell to the trade yet and would not be until I got them thoroughly introduced. Some of our good hardware men did not like it. I told them that as soon as the hardware men were ready to put in a sufficient stock to warrant it I would call off my agents and let them handle the squares. This has long since been done and now we are selling all of the productions of the L. S. Starrett Co. (the largest fine tool company in the world) through the hardware trade exclusively. Not only this, but we are helping them through our traveling men who are introducing the many new tools we are constantly bringing out, turning all orders over to the trade in the locality in which they operate.

* President, L. S. Starrett Co., Athol, Mass.

† Laroy S. Starrett has born in China, Me., April 25, 1836. He was the sixth child of Daniel D. and Anna Starrett, and was one of twelve children. He was brought up on a large farm under the hard, primitive conditions existing in America seventy-five years ago. All the clothes of the family were made from wool and flax raised on the farm and prepared by the mother and sisters, who carded, spun, wove, cut and fitted them to the members of the family. Mr. Starrett's father was handy with tools. He made ox-yokes, carts and sleds, not only for himself but for his neighbors. In fact both father and mother were ingenious and Mr. Starrett inherited a common-sense way of doing things and a love for working with tools. Working from five in the morning until nine at night, as was necessary under the hard conditions of life, begot habits of industry but prevented his getting more than a short term of schooling in the common district school. At seventeen he left home to earn money to help pay off a large mortgage on the farm. For ten years he turned in all of his wages not actually needed for clothes and other necessaries. When the farm was cleared of debt and his parents relieved from this anxiety, Mr. Starrett had saved about $100 and then he married Lydia W. Bartlett, a high-school graduate of Newburyport, Mass. In 1862 he rented a 600-acre farm with a large stock of cattle and horses and during Civil War days he ran the farm very successfully. He bought and used one of the first mowing machines seen in that part of the country. During this period, Mr. Starrett invented a washing machine, a butter worker and a meat chopper, all of which were patented. In the spring of 1865 he sold out his farming interests and hired a shop in Newburyport where he began manufacturing, making a specialty of the meat chopper. In 1868 he removed to Athol, Mass., and incorporated the Athol Mfg. Co. to manufacture the meat chopper and some other inventions, but after seven years he lost controlling interest in the concern and left to begin the manufacture of the combination square, as told in the accompanying article. Mr. Starrett's wife died in 1879, leaving one son and three daughters.

* * *

VALUE OF ADVERTISING IN TRADE PAPERS

The value of advertising in trade papers is indicated by a letter recently received, requesting the names of trade papers covering the automobile and motorcycle manufacturers and the manufacturers of their accessories. The writer stated that he was desirous of making up a good mailing list of these manufacturers and that while he knew such lists could be had from mailing houses who make a business of compiling them, he preferred to make up his own list and thus eliminate many useless names. He had found that trade papers were very valuable for this purpose, the inference being that live concerns advertise and thus are worth including in a mailing list. Firms that do not advertise are "dead wood," and many are in such an advanced state of decay that it is a waste of paper and postage to send them circulars.

* * *

MACHINE SHOP TERMS ILLUSTRATED

Backing Off

THE PRACTICAL SIDE OF SHERARDIZING*

THE PROCESS, THE APPARATUS AND METHODS EMPLOYED

BY CHESTER L. LUCAS†

NUMEROUS processes are employed for rust-proofing metal articles. Of these one general class is based on the application of a coating of zinc to the work. Of the zinc-coating processes, the oldest in common use is undoubtedly hot galvanizing. This is essentially a dipping operation in which the work, after being properly cleaned, is immersed in a tank of molten zinc. Another method of rust-proofing is the electro-galvanizing process which had its inception before hot galvanizing, but only until within the last few decades has it come into use. This is an electro-plating process, in which zinc is deposited from an anode onto the work. In addition to these two processes, there are others based on the immersion of the work in solutions of different kinds, and at least one in which the zinc dust is sprayed on the work while hot. Another zinc-coating process is sherardizing and it is the purpose of this article to outline the practical side of this interesting process.

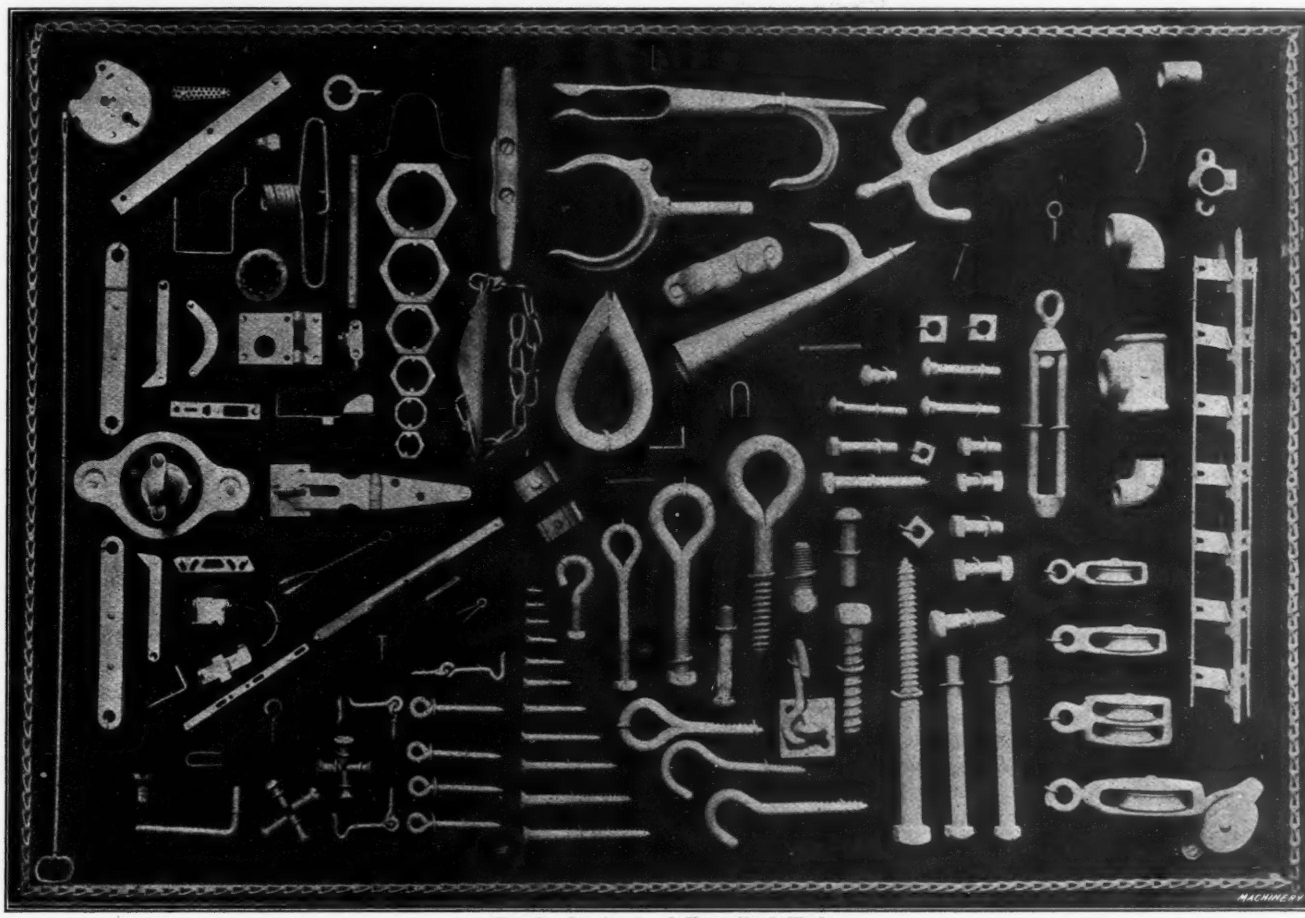

Fig. 1. Specimens of Sherardized Work

The Sherardizing Process

The sherardizing process was originated in England by Sherard Cowper-Coles about twelve years ago. Briefly, the process consists in sealing the work to be sherardized in metal retorts in conjunction with metallic zinc dust. The retorts are then heated until the work at the center has reached a temperature of from 500 to 700 degrees F., depending upon the nature of the work; at the same time the retorts are turned intermittently so as to give the zinc dust access to all parts of the work. After holding this heat for several hours, the time depending on the thickness of the coating desired, the drums are taken from the furnace and allowed to cool. When cool the work is finished. Fig. 1 shows specimens of sherardized work and gives an idea of the variety of articles that can be sherardized. These range from a watch screw to a roll of wire fencing. A sherardized surface is light gray in color, and the finish imparted is a fine matted surface resembling that obtained by sand-blasting. Fig. 2 shows a sherardized surface magnified seventy times which accounts for the rough appearance.

The action that takes place in sherardizing consists in forming both a zinc-iron alloy and a coating of zinc upon the material to be treated. The zinc dust becomes partially vaporized under the influence of the heat applied, and the vapor thus produced in condensing upon the hot iron forms the protecting coating, the inner layers of which alloy with the iron, while the outer layers provide additional surface protection of nearly pure zinc. Fig. 3 will perhaps make this point clear. This shows a section through a piece of low-carbon steel that has been sherardized. This has been magnified thirteen hundred times and plainly shows the body of the steel, the zinc-iron alloy section and the pure zinc coating above. It should be explained that this photograph was taken of a section formed by cutting through the stock and polishing the surface.

Advantages of the Sherardizing Process

Sherardizing has advantages over other methods of zinc coating, which may be classed under two heads; first, the superiority of the product and second, the economy of the process. The fact that the zinc coating penetrates unlike any other method of zinc coating, and amalgamates with the iron, makes a finish that cannot be worn or eaten away. In addition, the coating is so evenly applied and so thoroughly driven into the surface of the metal that it does not alter the exterior of the article to any appreciable extent. In fact, sherardizing is perfectly practical for the protection of threaded screws of fine pitch and it is not necessary to recut them after the coating has been applied if a slight clearance

* For additional information on sherardizing and other galvanizing processes previously published in MACHINERY see "A New Process for the Protection of Iron and Steel from Corrosion," November, 1904; "Cowper-Coles Galvanizing Process," December, 1905; "The Art of Galvanizing," February, 1908; "Sherardizing or Dry-galvanizing," August, 1908; "Machines for Sherardizing or Dry-galvanizing," December, 1909.

† Associate Editor of MACHINERY.

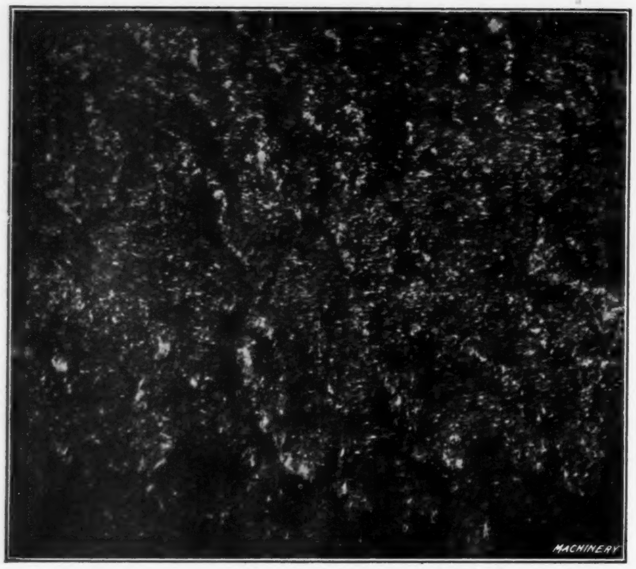

Fig. 2. Appearance of a Sherardized Coating magnified Seventy Times

is made when cutting the thread. Because of the nature of the process every part of the article treated is reached, the insides of tubes or sharp corners are coated just as thoroughly as the more exposed places. The depth of the coating may be controlled by the metallic percentage of the zinc dust, the length of time the heat is applied and by the temperature to which the retorts are subjected. There is no distortion of slender pieces or thin objects such as might occur when using the hot dip, because in sherardizing the heat is applied gradually and the work just as slowly cooled off.

The economy of the process is at once evident by the low heat required, the temperature of 500 to 600 degrees F. being far below the melting point of zinc, with is 786 F. Less zinc is required because none is wasted. The thin but thorough coating that is applied is just as effective as the thick rough coating that the hot galvanizing process gives. A sherardized coat of one-half ounce to the square foot affords more protection than a galvanized coating of one-and-a-half ounce to the square foot. No flux is necessary and the presence on the work of non-fatty oil in a moderate degree does not interfere with the sherardizing.

There is practically no limit to the metallic products that may be sherardized; in fact any articles that may be placed in the drum may be so treated. Oftentimes drums of special shape may be made to accommodate certain products. Screening, wire, etc., may be handled just as effectively as inflexible material by coiling it and placing it in that state in the drum. After sherardizing, the wire or screen may be straightened without injury to the coat of sherardizing.

Practically the only limitation to the sherardizing process is the fact that on very small tempered steel articles such as springs, the heat of six hundred degrees or thereabouts will draw the temper, leaving the metal in an annealed condition. On most work, however, this is not objectionable.

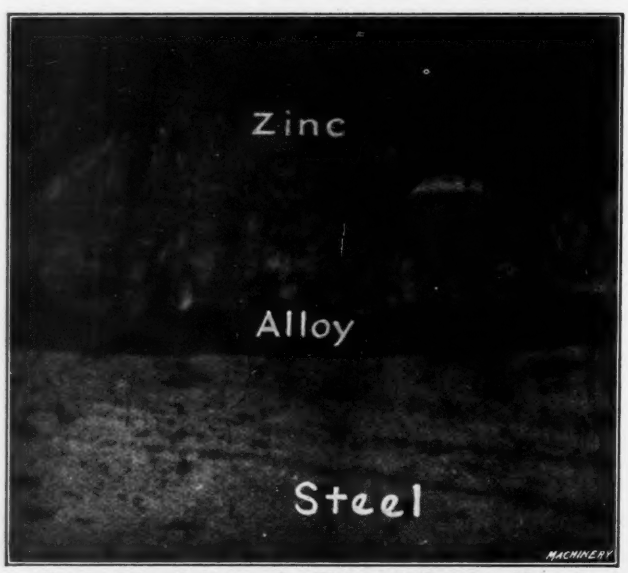

Fig. 3. Enlarged Cross-section Photograph through a Piece of Sherardized Steel magnified 1300 Times

The process of sherardizing is not confined to the coating of the product with zinc alone, but aluminum, tin, etc., are also used for sherardizing to good advantage. Zinc, however, is the leading metal on account of its ability to resist corrosion, due to its being electro-positive to iron.

Zinc for Sherardizing

The zinc dust used in the process of sherardizing is commercial zinc dust, of which at this time about ninety per cent is imported. On an average, the composition of this material runs about ninety per cent metallic zinc and ten per cent zinc oxide. Zinc dross is sometimes used, but not very successfully, as it will not alloy with the work being treated as intimately as the finely powdered zinc dust, although when the two are combined in equal parts they show good results. The best results are obtained when the zinc dust has been reduced to about fifty per cent metallic by the addition of spent zinc; therefore, new zinc should be reduced to that percentage as rapidly as possible.

Sherardized material requires a deposit of four pounds of zinc per hundred pounds of material treated, as an average. After the zinc has been reduced to the right percentage it may be held at that strength by simply replacing four pounds of new zinc for every hundred pounds of material treated, taking care that it is thoroughly mixed with the spent zinc dust. A chemical analysis of the dust in use once a month is recommended.

The Operation of Sherardizing

The basic patents for sherardizing are controlled in the United States by the United States Sherardizing Co. of New

Fig. 4. Loading a Sherardizing Drum

Castle, Pa. This company licenses subsidiary companies who, in turn, may license and instruct manufacturing companies in the art of sherardizing upon the payment of a royalty per ton of work treated by the process. Through the courtesy of one of these licensing companies, the New Haven Sherardizing Co., under the direction of A. F. Schoen, we are able to present an account of the operation of a sherardizing plant. The work illustrated in Fig. 1 was sherardized by this company.

Cleaning the Work

Sherardizing, like other zinc-coating processes, should have a clean surface to work upon. The presence of scale, rust or dirt greatly interferes with the sherardizing action. Machine products like screws and bolts require no cleaning other than an alkali dip. Sand-blasting is employed for cleaning relatively large pieces and an acid pickle is the common medium for removing scale. After cleaning with acid by the pickling process, the work should be thoroughly neutralized by placing it in a boiling solution of cyanide (mixture, one pound cyanide crystals to twenty gallons of water). A bright coating of zinc is assured, by taking these precautions.

The claim has been made that articles coming direct from the machine covered with oil can be sherardized without cleaning. This is true where no fats are used with the oil, and the zinc dust is new and of sufficient metallic strength to force itself through the oil. However, experiments along these lines have proved that after several operations, the material will come out very dark; therefore, considering the small cost of cleaning it should not be neglected.

Packing the Drums

The drums in which the work is packed with the zinc dust may be of any convenient shape and size to fit the furnace in which the work is to be done. The one shown in the illustration Fig. 4 is four and a half feet long and fifteen inches inside diameter. These are made of boiler plate with flanges at each end, upon which the end caps are bolted. In the event of the work being too long for the drum, two of these drums may be bolted together making an extra long drum. The operator shown in Fig. 4 is loading the drum with chains which he takes from the barrel that may be seen at the right. In the drum shown, about three hundred and fifty pounds of chain may be accommodated. The drums are filled in the same manner that a casehardening heat is prepared, first a shovelful of the zinc dust and then a shovelful of work is placed in the drum, and so on until the retort is filled to within about two inches of the top. This space is left to provide for expansion of the contents.

After the heads have been bolted on the drums, they are ready for the furnace. Fig. 5 gives an adequate idea of the way a sherardizing furnace is charged for firing. The laborer who fills the retorts, loads them upon a skeleton truck, the top of which has a cross track from which the drums may be rolled into the furnace by means of wheels slipped over their

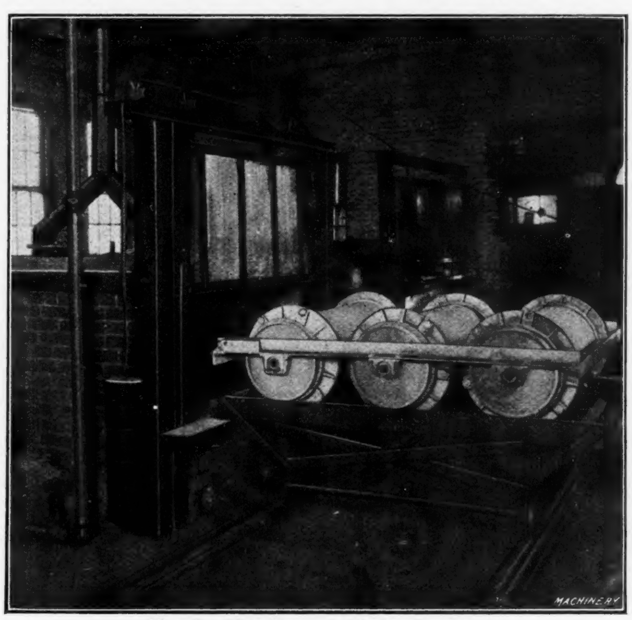

Fig. 5. Charging one of the Furnaces

ends. It will be noticed that the drums are spaced and held by an angle iron frame. This view shows the square sockets in the drum-caps, by means of which the drums may be turned while the sherardizing is going on.

The Sherardizing Furnace

The requirements of a furnace for sherardizing are not severe. On account of the fact that the maximum heat required to be imparted to the work is only from 500 to 700 degrees F., illuminating gas, natural gas, oil, coal or even coke may be used. The New Haven Sherardizing Co. is paying special attention to coke furnaces. In other lines of work coke furnaces have not been in general favor on account of the low amount of heat to be derived from this fuel, but as coke will give a sufficient heat for sherardizing, the economy of the coke furnace is apparent.

Figs. 6 and 7 show a new coke furnace made by the New Haven Sherardizing Co., for the purpose of sherardizing. This is a coke-burning furnace, although it can be used for soft coal or, in fact, any other fuel. It is especially valuable in urban districts where no liquid or gaseous fuel is avail-

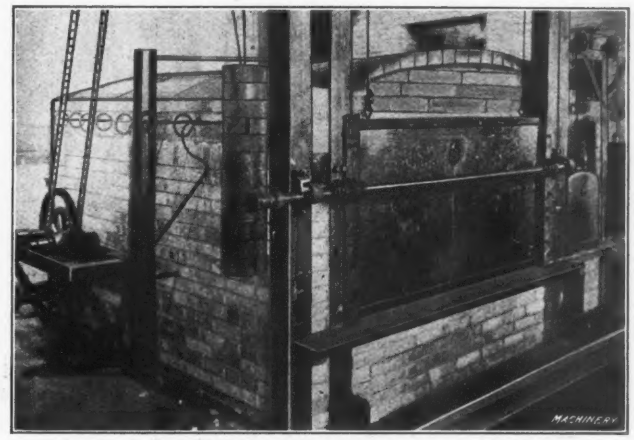

Fig. 6. A Coke-burning Furnace made by the New Haven Sherardizing Co.

able. The operating cost of this furnace is practically the same as for natural gas or producer gas. As Fig. 7 shows, it is made on the arch construction plan, employing a double arch. One of these arches is over the work chamber or oven and the second arch, which is larger, embraces the first arch and also the coke burning pocket at the side. Near the center of the arch over the work chamber, there are a number of rectangular openings. The heat passes up from the coke pocket to the top of the large arch, and is drawn downward through the rectangular openings into the furnace and onto the work. Each of these several openings is controlled by a separate damper whose handles may be seen at the left-hand side of the furnace in Fig. 6.

The furnace has an automatic drum turning feature which provides for the turning of the sherardizing drums at stated intervals. Intermittent turning of the sherardizing drum gives better results than the continuous rotation practice that has been advocated by some authorities. The work is much cleaner and brighter if not continuously rotated during the sherardizing process. In those plants where continuous rotation is practiced, the drums are turned one revolution every two minutes. When turned by hand intermittently, the operation is performed as shown in Fig. 8. Short squared shafts extend through the furnace wall and into the sockets in the ends of the drums. Every fifteen minutes the drums are given a half turn to mix the contents thoroughly and allow the heat and zinc to have access to all parts of the work. From the above, it will be seen that there are three methods in vogue for turning the sherardizing drums while under heat: *viz.*, continuous rotation, automatic intermittent turning and intermittent turning by hand. Above the squared shafts shown in Fig. 8 may be seen the pyrometer that indicates the furnace heat.

The temperature at which the furnace is kept varies according to the size of work being sherardized. From five hundred to seven hundred degrees F. marks the range limits, large work requiring the higher heat. The drums are kept heated for a period varying from four and one-half to five hours, ac-

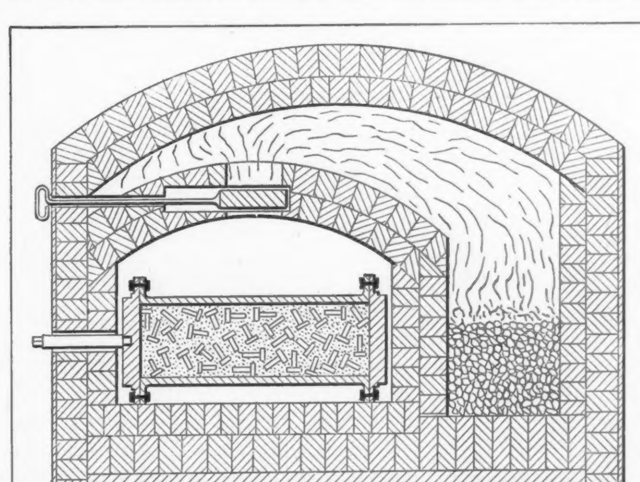

Fig. 7. Section through the Coke Burning Furnace

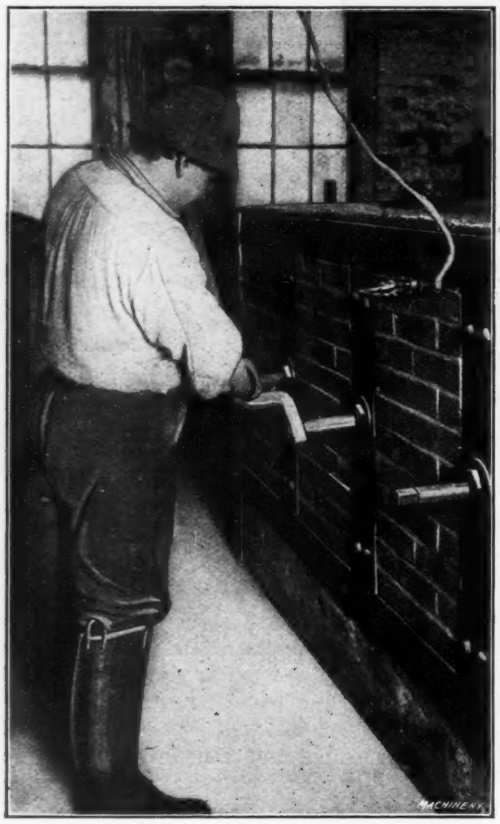

Fig. 8. Turning the Drums

Fig. 9. Removing the Sherardized Work from the Drum

cording to the depth of the sherardizing coat that it is desired to give the work.

Removing the Work

At the end of the prescribed time that the drums are kept under heat, they are rolled out of the furnace and allowed to cool slowly until they may be handled without inconvenience. The unloading operation is shown in Fig. 9. For this operation, the drum is hoisted to the mouth of a rotary screen and there emptied, the contents passing through the rotary screen. The work emerges at the outer end, while the zinc dust drops through the screen and out of the way. From the illustration it will be seen that the mouth of the screen leads out of a forge-like structure that catches the work as it is pulled from the drum and allows the floating dust to be carried away in the exhaust overhead. The work emerging from the farther end of the screen is caught in a second screen and the process repeated until at the end it is perfectly clean and free from all zinc dust.

The Cost of Sherardizing

There are four charges that enter into the cost of sherardizing. First is the royalty that must be paid to the owners of the process, second the labor cost, third the cost of the zinc dust and fourth the fuel charge. The royalty is in all cases approximately $2.50 per ton of material sherardized. The cost of the zinc dust required for a ton of work varies with the size of the work but is approximately $5, based on the use of eighty pounds of dust at 6¼ cents per pound. The labor cost for handling a ton of average work would be about $3. The fuel cost varies, being for producer gas $1.75 per ton, for illuminating gas $4 per ton, for natural gas 75 cents per ton, for crude oil 90 cents per ton and for coke 75 cents per ton. From these figures it will be seen that expense is no barrier to the use of this most efficient of rust-proofing processes.

* * *

COMPARISON OF HARDNESS TESTING APPARATUS

In experiments undertaken by M. Portevin, for the purpose of investigating the effect of heating steel for hardening in salt baths, an interesting characteristic of the Shore scleroscope test, as compared with the Brinell hardness test, was brought out. As is well known, the Brinell test consists in pressing a ball into the object the hardness of which is to be tested, the size of the depression under a standard pressure being a measure of the hardness. The Shore test consists of dropping a weight provided with a hard point upon the surface and the amount of rebound of the weight, as measured on a scale provided with the instrument, is the indication of the hardness. For many purposes, the Brinell test is considered the standard, and is generally acknowledged as being based on a more scientific principle than that of the Shore scleroscope, but for measuring surface hardness, as it was necessary to do in the experiments referred to, the Brinell method proved entirely inefficient and the scleroscope only gave reliable readings. The surface of the steel had been decarbonized for a depth varying from 0.07 to 0.060 inch. The Brinell test with a ball of 0.400 inch diameter gave practically the same readings for steel decarbonized only 0.07 inch as it gave for steel decarbonized for a depth of 0.060 inch, but the Shore scleroscope, which measures specifically the surface hardness, that is, the hardness of the layer of decarbonized material as considered apart from the total hardness of the whole specimen, showed very distinctly the soft condition of the surface. When the decarbonized surface was only 0.07 inch it showed a hardness of 80, while with a decarbonized surface of 0.060 inch the hardness on the scleroscope scale was only 32.

Two very important conclusions as regards the value of the scleroscope and the Brinell test for hardness testing can be drawn from these tests. In the first place, the scleroscope indicates primarily the surface hardness, and in a case where one is concerned with the total hardness of the material rather than with that of the thin layer on the surface, as, for instance, in testing ordinary structural material, the Brinell test is more accurate and dependable. On the other hand, when one is primarily concerned with surface hardness and less with the hardness of the main portion of the body being tested, as is the case with cutting tools or hardened objects generally, then the scleroscope appears to give a more reliable result. This conclusion agrees with the statements made many times by scientists and those that have occasion to test the hardness of materials, that both the scleroscope and the Brinell systems have their distinct fields of usefulness and that neither is likely to supersede the other.

* * *

One of the most expensive woods used regularly in an established industry in the United States is boxwood, the favorite material for wood engraving. It has been quoted at four cents a cubic inch, and at about $1300 by the thousand board feet.

DIE-CASTING MOLD FOR BALL BEARING SEPARATORS

There is one annular ball bearing on the market that differs from the general run of bearings in that the balls are closely spaced, being within 0.010 inch of each other in some sizes. This, of course, is an advantage to the bearing, as the load is distributed over a larger number of balls. To keep the balls in their correct running positions, a cast alloy separator is used, and a group of these separators for different sized

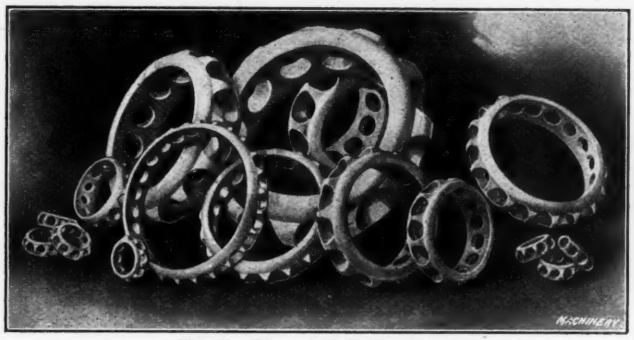

Fig. 1. Die-cast Ball Separators

ball bearings is shown in Fig. 1. These are made by the die-casting process by the German Bronze Co. of Erie, Pa., through whose courtesy the photographs of the molds shown in Figs. 2 and 3 are illustrated.

In common with most die-casting molds, the molds for these separators consist of two halves. The parting line on the casting comes in the exact center, bisecting the casting at the center line of the holes for the balls. In order to form the cavities for the balls, it is necessary to have a set of cores that may be thrown into an inner position while the casting is being made. Provision must also be made for removing these cores quickly so that the casting can be taken from the mold. Fig. 2 shows the two halves of the mold with the core-pins withdrawn to permit the casting to be taken from the mold, while Fig. 3 shows the lower die half with the core-pins in the casting position. Aside from the core-pins and the operating mechanism, the two halves of the casting mold each resemble the upper half shown at the right of the illustration, Fig. 2. In this illustration it will be seen that there are semicircular openings in the outer ring, and these, in conjunction with similar openings on the lower half, form the circular openings in which the cores work.

As this particular mold is for a separator for a twenty-five ball bearing, there are twenty-five core-pins *A*. These core-pins are operated by core-slides *B* that work in a cast-iron body seen at *C* through the slots. The core-slides are each fitted with roller studs *D* that engage in the slots in the core operating plate *E*. The long handle shown at the top is used for swiveling the core operating plate, and as the slots are inclined their action on the roller studs causes the core-pins to be thrown in or out in accordance with the direction in which the handle is moved. It will be appreciated that these core-pins and their operation are the important part of the mold. They must fit accurately in their bearings, but, most important of all, they must advance positively to the same limit each time the mold is closed; otherwise the cavities in which the balls operate would be of different depths. This is taken care of by having flanged ends to the core-pin slides, which act as stops and limit positively the advance of the core-pins. There is a chance for adjustment of the core-pins to increase or decrease the lengths to which they work into the molds. In making the mold, the inner ends of the core-pin were formed with a special forming tool that made them exactly alike and of the proper shape.

The making of one of these molds complete represents a total of approximately 350 hours' time. The operation of the mold is very successful, and the operator is able to turn out a substantial quantity per day. C. L. L.

* * *

ONE WAY OF LOSING THE STANDARD SIZE

BY A

Manufacturers of small tools very often receive orders for taps to duplicate a sample tap which is sent for the purpose. In itself, this is nothing unusual and little difficulty is encountered so far as the tap manufacturer is concerned, a possible exception being in the case of a sample tap which has an odd number of flutes or some such feature which makes it hard to obtain the correct dimensions. But when a repeat or duplicate order comes in, trouble begins. Another sample tap is sent with the order, and this would be all right provided the *same* tap were sent for both the original and the repeat orders. Such, however, is seldom the case, as it generally happens that the sample accompanying the second order is one of the taps made on the original order. In ninety-nine cases out of a hundred the taps made on the first order are of a different size from the sample, usually being larger.

After this performance has been repeated a few times, it is obvious that the last lot of taps will be several thousandths inch larger than the first sample, although the taps made on each separate order were well within commercial limits of accuracy, as compared with the sample sent, so that there is no just cause for complaint. The trouble caused by sending taps as samples to work from and thus losing the original standard is due to the fact that no matter what the tap maker is working to—either figures or samples—he always makes his limit *larger* than the specified dimensions. If a tap is made under size from a sample, it will invariably be rejected because a piece that is threaded standard size will not enter the tapped hole. If, on the other hand, the tap is made 0.001 inch larger than the specified dimensions, the tap will be accepted, as a standard threaded piece will go into the tapped hole with the same apparent amount of play as it entered a hole machined with one of the original taps. This emphasizes the importance of sending gages or specified dimensions for the tap maker to work from instead of sample taps.

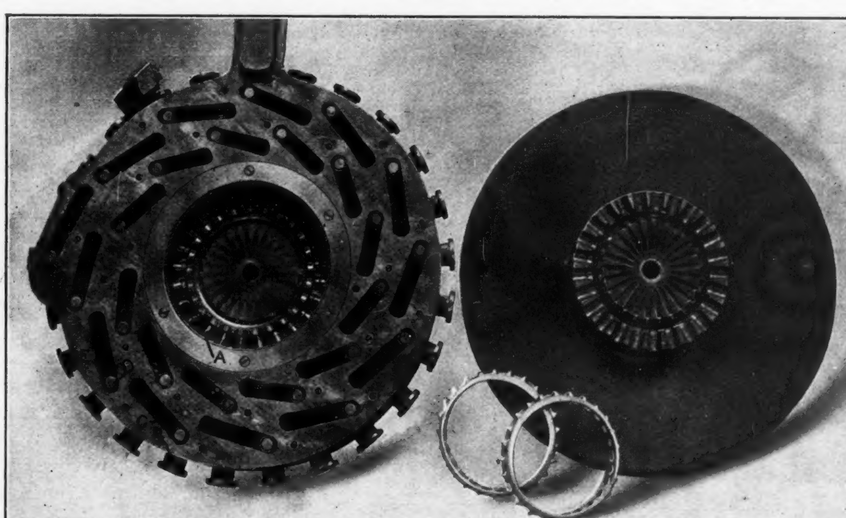

Fig. 2. Two Halves of Mold showing Cores withdrawn

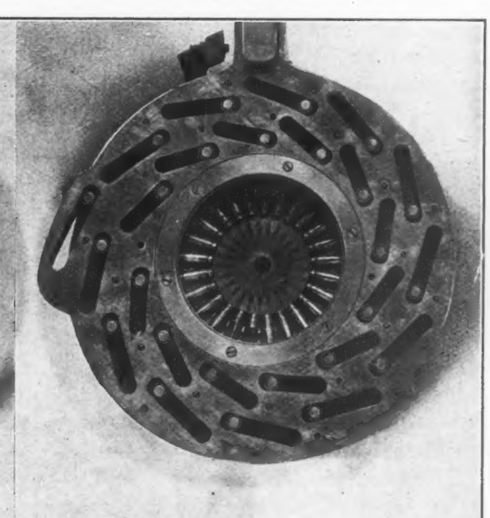

Fig. 3. Lower Half with Cores in Position for Casting

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WORKING FOREIGN PATENTS

The war which has paralyzed commerce with Germany and other European countries has directed attention to a grave defect in the United States patent laws. Patents granted to inventors by most European countries require the manufacture in that country of the article covered by the patent within a specified time; but no such clause appears in the United States patents, so that many foreigners whose works are located in Europe enjoy patent protection in the United States without the necessity of manufacturing here.

Some of our industries were in consequence nearly paralyzed with the cessation of over-sea commerce, because the materials necessary for carrying them on are controlled by foreign manufacturing concerns holding United States patents but not working them in this country. Our patent laws were enacted for the purpose of stimulating invention and manufacturing, and are based on the theory that the public will benefit from the unrestricted rights to manufacture or use at the expiration of the patent term. If, however, our people are barred from all participation in the benefits of manufacture within our borders during the term of a patent because it was granted to a foreigner, and in times of stress like these we can neither buy the patented product from abroad nor make it here, the injustice is apparent. Congressional action should be taken without delay to remedy this condition.

* * *

THE MEANS OF DESCRIPTION

The faculty of speech enables men to communicate ideas to one another. The knowledge acquired by one is imparted to others through the medium of language, and no individual is dependent for what he knows on what he can personally observe in his own lifetime. On the contrary, he can draw freely from the store of knowledge common to all mankind. The faculty of language is the most potent factor of uplift in the evolution of man.

One of the most important services rendered by a technical journal like MACHINERY is in affording readers the means of description. To be able to intelligently discuss a machine and its parts, to describe each part accurately in terms commonly accepted, marks the difference between the well-read and the uneducated mechanic. The uneducated mechanic resorts to similes and comparisons that are often vulgar and grotesque, but the well-read mechanic can speak in correct descriptive terms, and illustrate what he means by drawing, which is a graphic method of description.

If the average reader gained nothing else from perusing MACHINERY'S pages than the faculty of accurate expression and concise description, he would be well repaid for his trouble. Stop and think what it means to be able to name every part of a machine, to describe its function and its relation to the function of the machine as a whole. It is a great accomplishment and one that every man interested in any phase of mechanical work should endeavor early to acquire. One of the best ways of developing the faculty is writing, for we never know a subject even superficially until we try to put it on paper. Then we find how little we know about it; we discover the gaps in our knowledge that must be filled before a complete and accurate description can be written.

* * *

VALUE OF ORGANIZED SAFETY WORK

What organized effort can accomplish in eliminating accidents in rolling mills is indicated in a bulletin issued by the Illinois Steel Co., one of the constituent plants of the United States Steel Corporation. The effective work of the safety committee in the slabbing mill is reflected in the fact that this mill had no "lost time accidents" in the first seven months of 1914, although more than 125,000 tons of product were rolled. Accidents in the two plate mills were reduced approximately 65 per cent in the same period, as compared with the previous year.

Humanity learns its lessons chiefly by experience, and vicarious sacrifices have always seemed necessary to change ways that were wrong or dangerous, but cooperation and intelligent application of the lessons learned should materially reduce the accident toll of the future. Acting on this theory, the bulletin briefly describes accidents and calls attention to the errors of practice that caused them. The value of this is twofold. In the first place it warns men, foremen and superintendents of unsuspected dangers, and in the second place it stimulates them to avoid accidents for fear of being made the subject of a stinging sermonette in the next number of the bulletin. Organized safety work educates the men to avoid dangers, and it stimulates those responsible for production to develop discipline tending to lessen accidents throughout the plant.

* * *

CONSERVATISM IN REDESIGNING MACHINE TOOLS

One of the difficult questions for a manufacturing concern to decide is to what extent its product should be changed and improved from year to year. Changes of models and improvements are costly, not only in the first development, but in the manufacture. Manufacturing cost can be reduced to the lowest terms only when the equipment is devised solely with the view of specialization on one product. Even when a manufacturer is building one product, if he has a variety of models complication and loss of efficiency may ensue.

In the machine tool field, the temptation is strong to constantly improve and change existing models with the idea of attracting new customers. A concern that always has something new coming along is interesting and progressive, but in the light of hard, common sense it may not always be working for profit. One of the most successful automobile manufacturers has stuck closely to one model of machine, although hundreds of thousands have been built and the suggestions for changes have been many. This manufacturer had the backbone and the good business sense to stick to his model and improve his manufacturing methods rather than the product.

While conditions are of course different in the machine tool field, there is no doubt that many machine tool builders should devote more of their energies to the improvement of manufacturing methods rather than to the improvement of the product. The fact is that many so-called improvements are of doubtful value. Many devices applied to machine tools with the alleged purpose of facilitating output are rarely or never used by the operator. They are talking points used

mainly by persuasive salesmen to influence a decision in favor of his company's product. If the same manufacturer had improved his manufacturing methods so as to put his machine on the market at a lower cost, and at the same time use the very best materials available in its construction, he would be in a stronger position. Even though his selling price were lower, his reduced manufacturing cost would provide a margin between that and the selling price liberal enough to employ the best salesmen available. It is unfortunate that selling expense is so large a percentage of the price, but the successful manufacturer recognizes the conditions and adapts himself to them.

* * *

CAR COUPLINGS IN INDUSTRIAL PLANTS

Great improvements have been made in large industrial plants in promoting the safety of life and limb of employes, but much still remains to be done. One important improvement which would prevent the crippling of employes of industrial railroads is the adoption of some form of automatic coupler for industrial cars. The use of automatic couplers for railway cars has resulted in a greater saving of life and limb than any other improvement in railway operation except the air brake.

In steel plants, especially, are automatic couplings required for ingot and other small cars. The coupling and uncoupling of these cars is repeated many times a day, and the operation is always fraught with danger to some employe. There is no reason except that of initial cost for neglecting to make this improvement, for the time saved would alone make the change a paying one. It is generally conceded that the greatest loss of life and limb in coupling railway cars was in switching, and in industrial plants this class of service preponderates. In fact, it may be said to be practically 100 per cent of the service. Many of the state legislatures have passed laws intended to protect the lives and limbs of workers, and they should take this condition of large plants under consideration. Many thousands of small cars are used that are fitted with the old link-and-pin coupler, and this dangerous device—a veritable man-killer—should be replaced by automatic couplers, which would make unnecessary the entry of the employe between the cars to couple or uncouple.

* * *

SELLING PATENT RIGHTS

Often we are asked to recommend some individual or concern supposed to be in a position to sell a patent on an invention; but it is impossible to give definite information because no agency exists that can render such a service for patentees generally.

Selling patents is very different from selling machines or real estate. The range of things covered by patents is almost unlimited, and capitalists, manufacturers and others interested in promoting inventions for profit are widely distributed in enterprises of every description or attached to none at all. The work calls for innumerable experts. A person qualified to sell patents on shoe machinery would hardly be able to handle machine tool improvements or agricultural implements successfully. The technical side of a patent selling business would alone require encyclopedic knowledge in a person qualified to sell all kinds of patents, and the commercial side would demand a practical acquaintance with commercial conditions in almost every trade.

An inventor with ability enough to work out a practical and valuable invention should be able to apply his powers with equal energy to effecting such relations with others as will result in making his invention profitable. That such a combination of the inventive and commercial faculty rarely exists is not equivalent to saying that it cannot be developed. It can be; and a man who finds himself in possession of the inventive faculty should carefully study the commercial prospects and conditions and learn how to secure financial cooperation for his ventures. To merely invent is not sufficient; the inventor should be able to produce the children of his brain in shape for others to enjoy. The one who brings an idea into commercial form and places it within the reach of all is worthy of more recognition from every point of view than he who simply conceives the idea.

HINTS ON SELLING MACHINE TOOLS

BY C. H. S.

Although the bulk of the machine tools manufactured in this country is sold through dealers who sell iron working tools exclusively, a goodly portion is disposed of by jobbing houses who handle a general line of railway, mill and factory supplies. This article is intended particularly for the dealer who has not sufficient business of this nature to warrant him to employ a man exclusively on this work, but it is hoped that others engaged in the sale of machine tools may find a few suggestions that will help them increase their sales.

Possibly the first suggestion to the small dealer should be to select a line of tools that is best suited to the majority of the trade he expects to deal with. In other words, a line of cheap tools should not be considered in a manufacturing territory any more than a high priced line should be offered where the dealer has only small repair shops and garages to sell to. This selection should be made very carefully, in fact it might be well to tabulate a list of the possible customers in the territory. If this tabulation showed that 75 per cent were the kind that could not afford to buy the high grade tools it would appear advisable to take on a low or medium priced line. On the other hand, if a third of one's hoped-for customers were manufacturers, by all means take on the line of tools adapted to manufacturing purposes. Remember that shops engaged in manufacturing naturally grow in size and their tool purchases increase correspondingly, while the average repair shop after once being fitted out may not buy additional equipment for years.

After having sized up your territory and satisfied yourself that a certain class of tools will meet with favor in your particular trade, then take on tools in that line that are universally advertised. The fact that they are extensively advertised will not only help you in your sales, but it is pretty good proof that the tools are just what the manufacturers claim for them. The reason for this is that honesty in advertising machinery has been brought up to a higher standard than it ever has before, and it would now be considered very poor business to claim more for a tool than it can properly perform. After making the right selection stick to it through thick and thin. Do not offer a competing tool just because a customer prefers it or because the price is lower. Success in marketing machinery is dependable to a great extent on how closely the head of the business adheres to this policy. By so doing he secures not only the confidence of the manufacturer he represents but the customer's confidence as well. The manufacturer knows he is getting the representation he expected and the customer soon learns to respect the dealer who believes in the machines and tools he is selling, and is conscientious enough to offer his particular line regardless of whether he secures the order or not.

Assuming that the dealer has selected a line of tools that is extensively advertised, he should at once subscribe to the magazines or trade journals that carry most of the advertising that he is interested in. A copy for each salesman and a couple of office copies is not an extravagance by any means. The salesman should be instructed to read all of the advertisements carefully, not only of the tools he is selling but of competitors' tools as well. Thus he learns what his competitors are offering and he is better able to meet their competition. One thing to remember in the selling game is that it is just as important to know your competitor's product as it is to know your own, for in no other way can a salesman offer his wares intelligently.

Frequently the salesman's knowledge of a competitor's line will keep him from stating facts concerning his own that he would not mention if he knew what the other fellow was offering. This is not the only reason for suggesting that each salesman peruse the advertising pages of the machinery journals. He not only keeps informed of the progress of the different manufacturers in this way, but the suggestions continually appearing in the advertisements concerning improved methods of jigging and handling work, proper feeds and speeds, numerous testimonials, pictures of recent installations and names of large users all go to make up the most important selling information that can be put in a salesman's

hands. All advertisements of any importance should be cut out, carefully indexed and filed away. The office copies should be used for this. In a year or two the salesman will be surprised at the fund of valuable information accumulated.

It is a good thing for the small dealer to keep his principals informed concerning any important deals in his territory. If competition is keen on a certain prospect get the manufacturer to send you comparative data on his tools and the other fellow's. Frequently there is information in such data that cannot very well appear in the catalogues or advertisements because of its semi-confidential nature, but if offered judiciously by the salesman it may help him to "cinch" a sale. Now that most manufacturers of machine tools have service departments which will gladly go over a prospective customer's blueprints or samples and make time estimates and offer suggestions as to the best methods for handling the work, do not be afraid to call upon your manufacturers for this information. Remember they are specialists in their respective lines while you, on account of the varied nature of your work, cannot hope to be.

* * *

AN EIGHT DOLLAR STRADDLE MILLING FIXTURE

The accompanying illustrations show a straddle milling fixture that was built for the operation of squaring the ends of short lengths of brass rod stock. The diameter of the bar was one-half inch and the finished squared section was 3/8 inch diameter and squared to a depth of 1/4 inch. The fixture and method of operating are shown in Figs. 1 and 2. A base block is bolted to the table of the hand miller, and in its top face a square bottomed recess is bored 1/8 inch deep and of the same diameter as the part to be milled. A 3/8-inch slot 1/4 inch deep is milled into this depression from the side of the block. A gripping jaw is fitted into this slot, so that, when the handle is pulled upward, the jaw is forced inward and downward at the same time, thus gripping the piece and holding it against the bottom of the depression.

The gripping handle also serves as a means of changing the position of the fixture and work with relation to the cutters. One of these positions is shown in the illustrations and the fixture is swiveled against a pin and held there while the milling is being done, operating the table with the left hand lever. As soon as one cut is taken, the operator draws the table from the milling cutters and swivels the fixture with his right hand into a position at right angles to that formerly occupied. The second cut is then taken, and after again drawing the fixture from the cutters, he depresses his right hand thus releasing the grip on the work. It is thus thrown out and a new piece held. The milling is done on a Carter & Hakes hand milling machine. The operator is allowed to make $1.75 per day, and he gets four cents per gross for doing the work. Therefore it will be seen that approximately forty-four gross or over 6300 pieces represents a day's work, and the fixture cost less than eight dollars to build! C. L. L.

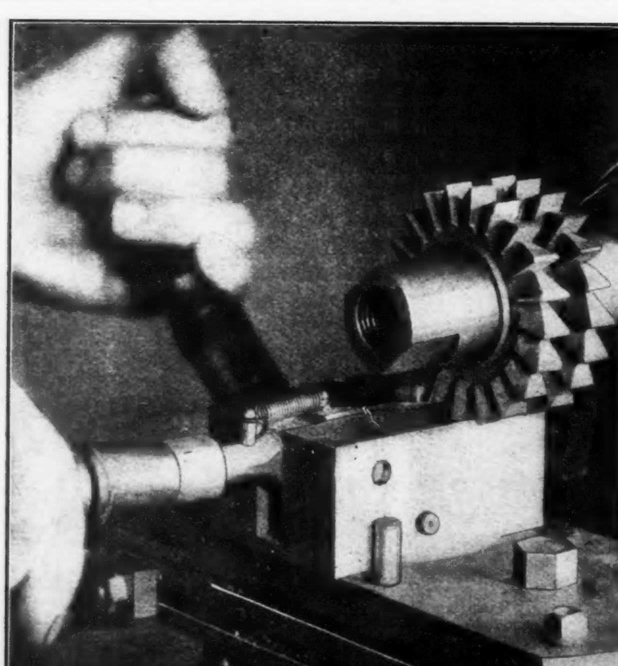

Fig. 1. Rapidly Operated Straddle Milling Fixture

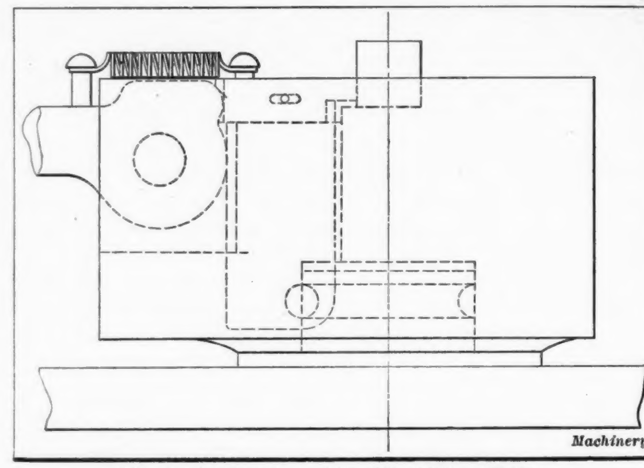

Fig. 2. Construction of Straddle Milling Fixture

* * *

SELECTION OF WHEELS FOR CYLINDRICAL GRINDING

BY C. H. NORTON*

I have read with interest an article by F. B. Jacobs in the October number on the selection of wheels for grinding. It would be interesting to some of us who are following for our life's work, and have been at it for thirty years, the grinding of cylindrical and other kinds of grinding wheel work to know just what Mr. Jacobs' connection with grinding is.

I am aware that many times—perhaps always—it is very difficult to make clear to the novice certain truths in regard to any specialty, and I will refrain from starting an argument in MACHINERY in regard to this, for the reason that the subject is so deep and has connected with it so many things that must be understood by both parties in the discussion before any good can come from such a discussion. I will, however, state as positively as Mr. Jacobs has that the depth of cut, work speed, width of wheel, etc., do have a very marked effect upon the grade and grain of wheel for any kind of grinding—both in finishing and production.

In another place Mr. Jacobs seems to discredit nearly all grinding wheel makers and grinding machine makers because one grinding wheel maker says you should finish with a fast work speed and another says that you should finish with a slow speed. I do not know where he got the idea that the Norton Grinding Co. said you should finish with a slow speed. I never said so, but did say and will say now that in a great many cases grinding with a slow work speed is a very good way to finish, and in order that the readers may not be confused about this, I will state that it is an absolute truth that you can finish work both ways if you want to. The reasons for selecting a slow or a fast speed at different times can be understood by no one except those who are thoroughly familiar with the art of grinding, and there probably is not space enough in one issue of MACHINERY to contain a thorough description of the art of grinding.

These discussions I consider fruitless and misleading, and it is questionable whether your readers are benefited by them, simply because no one writer can understand everything; and that is one great reason why I, even after thirty years of experience, have refrained from writing oftentimes upon this subject. I realize that I learn something every day and also that your readers, looking from different viewpoints, will be very likely to misconstrue what is written. The art of grinding is broader in its scope than the art of turning, planing, boring or almost any of the machine operations, and it has not yet been reduced to a science. But there are certain truths which are settled probably forever, and one of these is that the depth of cut and surface speed of work do affect the grade and grain of the wheel.

* Mechanical Engineer with the Norton Grinding Co., Worcester, Mass.

AUTOGENOUS SOLDERING OR WELDING OF ALUMINUM*

FLUXES FOR WELDING—MAKING WELDS WITH OXY-ACETYLENE TORCH—WELDING ALUMINUM-ZINC ALLOYS

BY FOREMAN JOINTER

THE term "autogenous" used in soldering or welding is one which is largely misapplied, except in the case of jointing lead, iron and steel. When the process is applied to aluminum a flux is absolutely necessary (a flux is also commonly used with iron); hence the use of the word "autogenous" is not quite accurate, although it has come to be generally accepted. The terms "autogenous soldering" and "autogenous welding" are somewhat similar, and variously applied; hence the need of a modern mechanical dictionary. Autogenous soldering or welding is sometimes spoken of as something modern, but as a matter of fact, the Romans used it a century or two B. C. for the jointing of lead pipes. However, the process of autogenous soldering or welding by means of the oxy-acetylene blowpipe only dates back to the year 1900.

Autogenous soldering, in the writer's opinion, is a form of welding in which the surfaces to be united are actually fused or melted, thereby causing them to flow together so as to form a strong union. The process is thus more akin to welding than to soldering proper; hence, in this article it will be defined as welding. Until the method of jointing aluminum by autogenous welding was perfected, its use was more or less restricted to those cases where jointing was of no great importance, or, not needed, but with the introduction of the oxy-acetylene system of blowpipe welding, the industrial applications of aluminum have received an enormous impetus, and it has not only supplanted other metals but various other materials in many branches of modern industries. The welding of aluminum joints, obviously, makes a much stronger and more intimate union than soft soldering, no interposition of any foreign metal being employed; hence the expansion and contraction of the finished part is uniform. This method is now extensively employed, as satisfactory welded joints are obtainable readily. It had long been recognized that this was the most hopeful direction in which to experiment, because such joints, containing as they do nothing but aluminum, would be as free from subsequent galvanic action as the metal itself; but the difficulty met with was in removing the oxide with which the metal is normally coated. However, this has now been overcome by the employment of suitable fluxes which have been put on the market. These vary considerably in quality, but several good fluxes now obtainable are capable of dissolving the film of oxide and permit the parts of the metal to flow satisfactorily together. The credit of having first welded aluminum must be conceded to the firm of Heraeus in Hanau, Germany, who exhibited at the Paris International Exposition in 1900 a number of aluminum articles which had been welded by means of a special process (German patent 118,868).

Fluxes for Welding Aluminum

In welding aluminum the most important factor in the process is the flux which performs the function of dissolving the oxide at the low melting point of the metal and, at the same time, protects the hot metal from contact with the air. To produce a flux that will remove the oxide film has not been a simple problem to the chemist and engineer, and only during the last few years have such fluxes been obtainable. When it is explained that while the melting point of metallic aluminum is 657 degrees C., that of the oxide is nearly 3000 degrees C., the difficulty of this problem no doubt will be appreciated. As in the case of soft soldering, the rapidity with which the flux acts is an important factor in its utility.

Many fluxes for welding aluminum are employed with satisfactory results, consisting chiefly of the following ingredients in varying proportions: aluminum chloride, lithium chloride, potassium chloride, sodium chloride, and calcium chloride; also aluminum fluoride, calcium fluoride, potassium fluoride, etc.

Welding Aluminum with Oxy-acetylene Torch

In welding aluminum with the oxy-acetylene blowpipe, it is essential that the acetylene and the oxygen used must be in a state of high purity, as at the great temperature of the welding flame, aluminum tends to absorb nitrogen, and if this impurity exists in the oxygen it will render the work brittle and unreliable. It is known to those who have attempted to weld aluminum by means of the oxy-acetylene flame, that when two pieces of the metal are to be welded together at their edges, the melted parts do not flow together properly, as in the case of iron where the melting point of the oxide is lower than that of the metal. The molten aluminum spreads in spherical form under the influence of the welding flame. These metallic pellets consist of pure aluminum within a coating of alumina (oxide of aluminum) which has great power of resistance to the flame, and on cooling, the edges of the metal remain unjoined; hence the need of a flux to remove the oxide film and permit the fused metal to flow satisfactorily together.

When welding aluminum, it is essential to guard against undue expansion and contraction by preheating and annealing effectively. The low temperatures dealt with when welding aluminum make the preheating easy, but care must be taken not to exceed the fusion temperature, as the fluidity of aluminum necessitates the employment of great dexterity to prevent the deformation of the metal under the blowpipe. When melting new metal for filling the joint, on aluminum ⅛ inch in thickness or more, one end of the feeder should be constantly submerged in the molten metal in the welding groove. By this method, an experienced welder, by judicious and rapid movement of the blowpipe flame, can completely prevent burning and, at the same time, effect a perfect weld. It must be remembered, however, that the fusion point of this metal is very low; hence the welding flame should be kept further away from the metal than is usually the case when welding iron or steel. The flame should be so adjusted as to furnish a slight excess of acetylene.

When welding small articles by the oxy-acetylene welding flame, the operator is confronted with several difficulties, especially if the articles are manufactured of sheet aluminum, as the expansion and contraction due to temperature changes is very rapid; therefore, the operator must guard against distortion of the work. Holes are also liable to be made in thin metal, particularly if due care is not taken, although an experienced aluminum welder can effect satisfactory welds in sheet aluminum 0.008 inch in thickness.

Some specimens of sheet aluminum which have been joined by autogenous welding are shown in Fig. 1. The aluminum sheet *A* is 0.064 inch thick and was welded by a beginner, with the oxy-acetylene torch. The weld *B* has a good appearance on the top surface, but thorough fusion has not occurred. Good fusion welds are shown at *C* and *D*; the aluminum sheet *C* is 0.048 inch thick, and *D*, 0.116 inch thick. The flanged weld *E* was improperly made; thickness of aluminum, 0.048 inch. The flanged weld *F* was properly made and afterward hammered.

When making a butt-weld on thin sheet aluminum it will be found advantageous, if the position of the work is suitable, before abutting and jointing the two pieces, to turn the edges up at right angles so as to form sufficient excess of metal for filling in the joint. By this method it will clearly be seen that heterogeneous metal does not enter the weld, the joint being entirely composed of metal identical with the surfaces to be joined. Feeders of doubtful quality should be avoided.

Tests of welds effected by the oxy-acetylene process on commercial sheet aluminum 0.094 inch thick have recently been made. These welds were very brittle, although they had been made by an expert in welding sheet aluminum. The feeder used as added metal was pure aluminum, and the de-

* For articles on this and kindred subjects, see "Soldering and Brazing Aluminum," December, 1914; "Electrical Soldering," June, 1914; "Autogenous Welding or Autogenous Soldering," April, 1914; "Manufacture of Tubing by Autogenous Welding" and articles referred to, January, 1912.

oxidizing flux employed had never given rise to such a difficulty previously. The abnormal brittleness found in the welded test-pieces, it was concluded, was attributable to the impurities in the metal. This brittleness is also found in pure sheet aluminum, although in a somewhat lesser degree. It is known that in the process of welding, internal strains are inevitably set up, the physical and mechanical properties of the metal being altered; therefore, in order to obtain a perfect and homogeneous weld it is desirable to reheat the metal from 450 to 500 degrees C. This causes molecular rearrangement to take place within the metal and sets up greater homogeneity in the weld zone, thus eliminating the

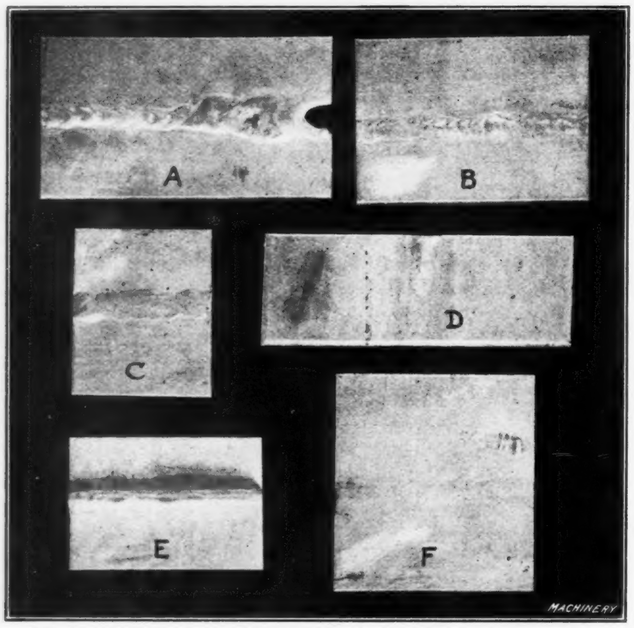

Fig. 1. (A) Weld made by Beginner. (B) Fusion not Thorough. (C) A Good Weld on 0.048-inch Stock. (D) A Good Weld on 0.116-inch Stock. (E) Flanged Weld improperly done. (F) A Hammered Flanged Weld

effect of the excessively rapid heating undergone during the welding process, and, consequently, improving the quality of the metal.

The success of welding aluminum autogenously depends to a great extent on the intelligence and ability of the operator. It is possible for a competent welder, at his own discretion, to give a greater or less strength to the welded part, and for this reason it is impossible to draw conclusions from the work of one operator as to the work of another. An expert in aluminum welding is distinguishable by his tact in the preparation of the surfaces to be welded; judgment in preheating and reheating (or annealing) of the work; the choice of a well constructed blowpipe; the determination and maintenance of the correct proportions of oxygen and acetylene issuing from the nozzle of the blowpipe; in the entire application of the system; the estimation of the area to be fused in each partial operation; the manipulation of the welding flame at the right moment when fusion has proceeded so far that complete welding is assured; the dexterity in preventing the deformation of the metal under the blowpipe; and lastly, the rapidity and ease of the operation, thereby preventing the overheating of the metal and the avoidance of burnt welds.

The writer has often seen oxy-acetylene welding carried out efficiently on iron and steel by expert workmen, who, when transferred to the welding of aluminum, produced unsatisfactory work until they became proficient with the metal. Welding operators frequently undertake work on aluminum and its alloys without sufficient experience and fail in consequence.

Welding Aluminum-Zinc Alloys

Alloys of aluminum and zinc present much the same difficulties as are encountered in welding the pure metal. These alloys are now extensively used in the automobile, aeronautical and kindred industries where strength combined with lightness is a necessity. As with the pure metal, preheating and effective annealing are essential. A typical automobile repair job is shown in Fig. 2, which illustrates the crank-chamber or gear-case. The upper view shows the fractured gear-case, whereas the lower view shows the same case repaired by autogenous welding. In actual operation, the correct method is to preheat tne article before welding, to about 400 or 450 degrees C., but the heating should be done slowly so as to obviate ruptures from unequal expansion.

Breakages during heating and cooling must be avoided, more so than in the case of pure aluminum, for between 500 and 550 degrees C. the alloys become friable and their tenacity practically disappears; without proper support a portion may easily break off during the heating process. Another advantage of preheating is that oily and fatty matters are expelled; these are often retained by the metal in considerable quantity owing to its porosity. When a repair is carried out too soon, the oil carbonizes and adheres to the edges of the metal to be welded, thus impeding proper coherence of the two surfaces to be joined.

During the welding process a special flux should be used, which breaks down the oxide, and prevents oxidation of the metal when under fusion. A compound containing the chlorides of potassium, lithium, sodium and other elements performs this function with success; many good fluxes are on the market. A typical patent flux consists of 60 parts potassium chloride, 6 parts cryolite (an aluminum sodium double fluoride), and 30 parts calcium chloride, but the proportions might be varied within considerable limits.

The added metal should have practically the same composition as the material being welded. The necessary alloys of aluminum and zinc are not always readily obtainable as feeders, especially in the form of strips, which are preferable, so that many operators use pure aluminum during the

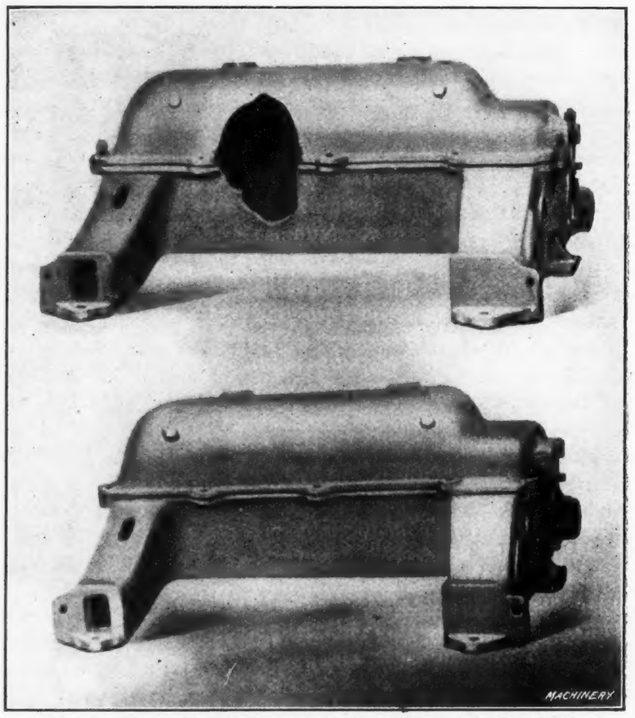

Fig. 2. Fractured Aluminum Gear Case before and after being welded with Oxy-acetylene Blowpipe

welding process. However, the adding of molten metal from feeders of pure aluminum should be strictly avoided; this if an alloy containing, say 25 per cent of zinc, is being welded its melting point will be approximately 50 degrees C. lower than that of the aluminum added, the result being increased difficulty in working, and incoherency of the parts rather than a true autogenous weld. Moreover, if pure aluminum is used the weld-zone will be softer and more flexible than the rest of the work, and this lesser resistance is a defect which should be avoided. In addition, the weld-zone, if too soft, will be almost certain to break out again, and it is essential that the added metal should contain a percentage of zinc, so that the weld-zone will have a hardness approximately equal to that of the rest of the article. The conditions as stated should be observed as nearly as possible if one wishes to obtain a true autogenous weld. It will be gath-

ered from the foregoing that perfect welds are thus readily attained in aluminum and the aluminum-zinc alloys by those having adequate knowledge of how to employ this new art correctly.

Practical Hints on Autogenous Welding of Aluminum

1. To weld aluminum properly and to make a thoroughly sound and homogeneous joint, requires skill and training and a knowledge of how to design and prepare the work for being welded, as well as to make the weld.

2. In order to obtain the best results in welding aluminum, it is essential that the acetylene and the oxygen should be in a state of high purity. Acetylene obtained from practically all small generators is impure.

3. Before attempting to weld, see that the blowpipe is in good order, and that the tubing is sound and securely fixed; also that the regulator on the oxygen cylinder is in proper working order and passing gas without fluctuation.

4. Be sure to have an ample supply of acetylene and oxygen before beginning to weld, as it is injurious to the weld to stop in the middle of the operation.

5. Remember that the melting-point of the oxide of aluminum is not only much higher than that of the metal, but it is also heavier than the molten aluminum.

6. Wear suitable glasses (smoked or colored) when welding, in order to avoid serious injury to the eyesight.

7. In order to relieve the metal from internal strains due to welding, preheating and reheating (or annealing) should be properly effected. These operations should be carried out in the absence of air, and where possible in a special furnace. When preheating and reheating, take the necessary precautions to avoid melting the metal; when heated above 500 degrees C. aluminum becomes fragile and is very easily deformed under its own weight.

8. Thoroughly clean the surface and edges of the metal where the welding is to be done, to avoid the impurities which set up automatic disintegration in the line of welding.

9. It should not be assumed that a blowpipe of any size is suitable for all thicknesses of aluminum; it is most essential to select a blowpipe of the right size. A blowpipe consuming 50 liters (1.76 cubic foot) or even 25 liters (0.88 cubic foot) of acetylene per hour can be employed satisfactorily on sheets 1/16 inch in thickness, whereas aluminum 1/4 inch thick requires a blowpipe consuming 700 to 800 liters (24.7 to 28.2 cubic feet) per hour.

10. Do not attempt to weld without a flux; in spite of all precautions that may be taken, a weld made without a flux is never perfectly homogeneous. It is only by employing a suitable flux which will cause the oxide to dissolve at the same temperature as the aluminum becomes molten, that a perfect weld can be obtained.

11. When making up powders to be used for fluxes, thoroughly dry the ingredients, so as to avoid their combination with each other and their shriveling up under the action of the blowpipe. (Unfortunately the best fluxes are hygroscopic and should be powdered before use as they are liable to become granulated).

12. The flux should not be thrown on the weld in excess, as the brazier does when brazing copper or brass; it should be added from the welding rod, by first warming the rod with the blowpipe flame, then dipping it into the vessel containing the flux, which readily adheres to the rod. It will then flow ahead of the blowpipe flame and "prepare" the metal.

13. Aluminum is not as readily welded as iron. In aluminum welding it is essential to remove the refractory oxide with which the metal is normally coated. The fluidity of melted aluminum is very great.

14. Do not be discouraged if you have successfully welded iron and have attempted to weld aluminum and failed; in order to obtain autogenous welds on aluminum a different mode of procedure is necessary. An iron welder generally finds it difficult to learn aluminum welding, since aluminum is to him a strange metal.

15. In a perfect weld the junction of the two pieces should have the same chemical composition and the same physical properties as the joined pieces. No line of demarkation should be visible under the microscope.

16. When preparing sheets or plates 1/8 inch in thickness or more, bevel the edges. The width of the V formed, when the edges are together, should be at least as great as the thickness of the work; the beveling should be done right to the bottom edge, so as to enable the metal to be melted throughout its entire thickness.

17. The diameter of a welding rod should, preferably, be about equal to the thickness of the metal. In practice, feeders above 1/4 inch in diameter are not advisable. A very useful form of feeder is an aluminum rod with a core of the welding flux down the center, making the welding metal self-fluxing.

18. The welding of thin sheets is facilitated by flanging the edges; the depth of the flange formed should slightly exceed the thickness of the metal, so as to form an excess of metal at the joint to serve for filling in without any additional metal.

19. When using feeders on thin welds it is preferable to hold the feeder in front of the blowpipe in the direction of the edges to be welded; it is also essential for the flame to be held practically perpendicular to the work, pointing slightly in the direction of travel. The apex, or outer extremity, of the white jet of the flame should be kept some distance from the work, depending on the thickness to be welded.

20. When welding aluminum 1/8 inch in thickness or more, the feeder and the edges to be joined should be melted simultaneously. On no account must globules from the feeder fall onto the surface of the work.

21. Never use a steel tool to clear the hole in the nozzle of the blowpipe should it be obstructed at any time, because it is likely to damage it; copper wire should be employed.

22. The experienced operator, when welding thin sections of aluminum, displays his skill by raising the flame just at the moment when fusion has proceeded so far that complete welding is assured.

23. Thoroughly cleanse by brushing, the lines of the welding and adjacent surfaces in clean warm water, so as to remove completely the effects of the flux, which otherwise would set up corrosion of the metal.

24. When possible, cold hammering and annealing improve the line of welding. Do not allow cavities to form in the weld, as they diminish the strength of the joint considerably. A good fusion weld seldom breaks at the point of welding.

25. The alloys of aluminum and zinc present the same difficulties as pure aluminum; the operator must use the same flux, and take precautions against the effect of expansion and contraction in carrying out welds on articles made of these materials. After welding very little zinc is left in the vicinity of the weld.

26. Pure aluminum should not be used for welding aluminum and zinc alloys, as the pure metal does not give a perfect weld, the welded zone being more flexible, but much softer than the rest of the material.

27. Good results cannot be obtained if the metal is welded in a dilatory manner; welds on aluminum should be expeditiously executed from the moment the first fusion is obtained, *i. e.*, the rate of travel should be a fast uniform one.

* * *

TALC AS A LUBRICANT

A German chemical journal contains an article relating to the use of talc for lubricating purposes. Talc does not behave like graphite when treated with tannin solutions, but it may be brought into a fine molecular state by heating it with ammonium carbonate or by exposing it for several hours to a current of dry ammonia. The talc is afterward dried in a vacuum. The treated material can be suspended in water so that it is very difficult to filter it, and subsides exceedingly slow in lubricating oils of medium density. When once suspended in a neutral oil, the talc does not subside on heating. The change in the character of the talc is attributed to the absorption of a minute quantity of ammonia. From 40 to 60 per cent of ordinary talc may be introduced into heavy mineral oil, provided the oil be added to the talc and the operation not carried on in the reverse manner.

PITCH DIAMETERS OF BALL BEARINGS

BY GEORGE C. HANNEMANN*

The tables presented in this connection give the pitch diameters to the next highest 0.001 inch of the ball circles of ball bearings with the balls touching. To use these tables in the design of ball bearings of the "noiseless" type, an allowance of from 0.0003 to 0.001 inch per ball should be added to the diameters here given, depending on the size of bearing balls to be used.

* Address: Care of Auburn Ball Bearing Co., Rochester, N. Y.

TABLE I. PITCH DIAMETERS WITH BALLS TOUCHING

No. of Balls	Diameter of Balls in Inches					
	1/8	5/32	3/16	7/32	1/4	9/32
5	0.213	0.266	0.319	0.373	0.426	0.479
6	0.250	0.313	0.375	0.438	0.500	0.563
7	0.289	0.361	0.433	0.505	0.577	0.649
8	0.327	0.409	0.490	0.572	0.654	0.735
9	0.366	0.457	0.549	0.640	0.731	0.823
10	0.405	0.506	0.607	0.708	0.810	0.911
11	0.444	0.555	0.666	0.777	0.888	0.999
12	0.483	0.604	0.725	0.846	0.966	1.087
13	0.523	0.653	0.784	0.915	1.045	1.176
14	0.562	0.703	0.843	0.984	1.124	1.264
15	0.602	0.752	0.902	1.053	1.203	1.353
16	0.641	0.801	0.962	1.122	1.282	1.442
17	0.681	0.851	1.021	1.191	1.361	1.531
18	0.720	0.900	1.080	1.260	1.440	1.620
19	0.760	0.950	1.140	1.330	1.519	1.709
20	0.800	0.999	1.199	1.399	1.599	1.798
21	0.839	1.049	1.259	1.468	1.678	1.888
22	0.879	1.098	1.318	1.538	1.757	1.977
23	0.918	1.148	1.377	1.607	1.836	2.066
24	0.958	1.198	1.437	1.676	1.916	2.155
25	0.998	1.247	1.497	1.746	1.995	2.245
26	1.038	1.297	1.556	1.815	2.075	2.334
27	1.077	1.346	1.616	1.885	2.154	2.423
28	1.117	1.396	1.675	1.954	2.233	2.512
29	1.157	1.446	1.735	2.024	2.313	2.602
30	1.196	1.495	1.794	2.093	2.392	2.691
31	1.236	1.545	1.854	2.163	2.472	2.781
32	1.276	1.595	1.913	2.232	2.551	2.870
33	1.316	1.644	1.973	2.302	2.631	2.959
34	1.355	1.694	2.033	2.371	2.710	3.049
35	1.395	1.744	2.092	2.441	2.789	3.138
36	1.435	1.793	2.152	2.510	2.869	3.227
37	1.474	1.843	2.211	2.580	2.948	3.317
38	1.514	1.893	2.271	2.649	3.028	3.406
39	1.554	1.942	2.331	2.719	3.107	3.496
40	1.594	1.992	2.390	2.789	3.187	3.585

Machinery

TABLE II. PITCH DIAMETERS WITH BALLS TOUCHING

No. of Balls	Diameter of Balls in Inches					
	5/16	11/32	3/8	7/16	1/2	9/16
5	0.532	0.585	0.638	0.745	0.851	0.957
6	0.625	0.688	0.750	0.875	1.000	1.125
7	0.721	0.793	0.865	1.009	1.153	1.297
8	0.817	0.899	0.980	1.144	1.307	1.470
9	0.914	1.006	1.097	1.280	1.462	1.645
10	1.012	1.113	1.214	1.416	1.619	1.821
11	1.110	1.221	1.332	1.553	1.775	1.997
12	1.208	1.329	1.449	1.691	1.932	2.174
13	1.306	1.437	1.567	1.829	2.090	2.351
14	1.405	1.545	1.686	1.967	2.247	2.528
15	1.504	1.654	1.804	2.105	2.405	2.706
16	1.602	1.763	1.923	2.243	2.563	2.884
17	1.701	1.871	2.041	2.381	2.722	3.062
18	1.800	1.980	2.160	2.520	2.880	3.240
19	1.899	2.089	2.279	2.659	3.038	3.418
20	1.998	2.198	2.398	2.797	3.197	3.596
21	2.097	2.307	2.517	2.936	3.355	3.775
22	2.196	2.416	2.636	3.075	3.514	3.953
23	2.295	2.525	2.754	3.213	3.672	4.131
24	2.395	2.634	2.873	3.352	3.831	4.310
25	2.494	2.743	2.993	3.491	3.990	4.489
26	2.593	2.852	3.112	3.630	4.149	4.667
27	2.692	2.961	3.231	3.769	4.307	4.846
28	2.792	3.071	3.350	3.908	4.466	5.024
29	2.891	3.181	3.470	4.048	4.626	5.204
30	2.990	3.289	3.588	4.186	4.784	5.382
31	3.089	3.398	3.707	4.325	4.943	5.561
32	3.189	3.508	3.826	4.464	5.102	5.739
33	3.288	3.617	3.946	4.603	5.261	5.918
34	3.387	3.726	4.065	4.742	5.419	6.097
35	3.487	3.835	4.184	4.881	5.578	6.276
36	3.586	3.945	4.303	5.020	5.737	6.454
37	3.685	4.054	4.422	5.159	5.896	6.633
38	3.785	4.163	4.542	5.298	6.055	6.812
39	3.884	4.272	4.661	5.438	6.214	6.991
40	3.983	4.382	4.780	5.577	6.373	7.170

Machinery

TABLE III. PITCH DIAMETERS WITH BALLS TOUCHING

No. of Balls	Diameter of Balls in Inches				
	5/8	11/16	3/4	13/16	7/8
5	1.064	1.170	1.276	1.383	1.489
6	1.250	1.375	1.500	1.625	1.750
7	1.441	1.585	1.729	1.873	2.017
8	1.634	1.797	1.960	2.124	2.287
9	1.828	2.011	2.193	2.376	2.559
10	2.023	2.225	2.428	2.630	2.832
11	2.219	2.441	2.663	2.884	3.106
12	2.415	2.657	2.898	3.140	3.382
13	2.612	2.873	3.134	3.396	3.657
14	2.809	3.090	3.371	3.652	3.933
15	3.007	3.307	3.608	3.908	4.209
16	3.204	3.525	3.845	4.165	4.486
17	3.402	3.742	4.082	4.422	4.762
18	3.600	3.960	4.320	4.680	5.039
19	3.798	4.177	4.557	4.937	5.317
20	3.996	4.395	4.795	5.194	5.594
21	4.194	4.613	5.033	5.452	5.871
22	4.392	4.831	5.271	5.710	6.149
23	4.590	5.049	5.508	5.967	6.426
24	4.789	5.268	5.746	6.225	6.704
25	4.987	5.486	5.985	6.483	6.982
26	5.186	5.704	6.223	6.741	7.260
27	5.384	5.922	6.461	6.999	7.538
28	5.583	6.141	6.699	7.257	7.815
29	5.782	6.361	6.939	7.517	8.095
30	5.980	6.578	7.176	7.773	8.371
31	6.178	6.796	7.414	8.032	8.649
32	6.377	7.015	7.652	8.290	8.928
33	6.576	7.233	7.891	8.548	9.206
34	6.774	7.452	8.129	8.806	9.484
35	6.973	7.670	8.367	9.065	9.762
36	7.172	7.889	8.606	9.323	10.040
37	7.370	8.107	8.844	9.581	10.318
38	7.569	8.326	9.083	9.840	10.596
39	7.768	8.544	9.321	10.098	10.875
40	7.966	8.763	9.560	10.356	11.153

Machinery

TABLE IV. PITCH DIAMETERS WITH BALLS TOUCHING

No. of Balls	Diameter of Balls in Inches				
	15/16	1	1 1/8	1 1/4	1 1/2
5	1.595	1.702	1.914	2.127	2.551
6	1.875	2.000	2.250	2.500	3.000
7	2.161	2.305	2.593	2.881	3.458
8	2.450	2.614	2.940	3.267	3.920
9	2.742	2.924	3.290	3.655	4.387
10	3.034	3.237	3.641	4.046	4.855
11	3.328	3.550	3.994	4.437	5.325
12	3.623	3.864	4.347	4.830	5.796
13	3.918	4.179	4.701	5.224	6.268
14	4.214	4.494	5.056	5.618	6.741
15	4.510	4.810	5.411	6.013	7.215
16	4.806	5.126	5.767	6.408	7.689
17	5.103	5.443	6.123	6.803	8.164
18	5.399	5.759	6.479	7.200	8.639
19	5.696	6.076	6.835	7.595	9.114
20	5.993	6.393	7.192	7.991	9.589
21	6.291	6.710	7.549	8.387	10.065
22	6.588	7.027	7.906	8.784	10.541
23	6.885	7.344	8.262	9.180	11.016
24	7.183	7.662	8.619	9.577	11.492
25	7.481	7.979	8.977	9.974	11.969
26	7.778	8.297	9.334	10.371	12.445
27	8.076	8.614	9.691	10.768	12.921
28	8.374	8.932	10.048	11.165	13.398
29	8.673	9.252	10.408	11.564	13.877
30	8.969	9.567	10.763	11.960	14.351
31	9.267	9.885	11.121	12.356	14.827
32	9.565	10.203	11.478	12.753	15.304
33	9.863	10.521	11.836	13.151	15.781
34	10.161	10.838	12.193	13.548	16.257
35	10.459	11.156	12.551	13.945	16.734
36	10.757	11.474	12.908	14.343	17.211
37	11.055	11.792	13.266	14.740	17.688
38	11.353	12.110	13.624	15.137	18.165
39	11.651	12.428	13.981	15.535	18.642
40	11.949	12.746	14.339	15.932	19.119

Machinery

THICKNESS OF CYLINDER WALL

BY THOMAS N. HAFFNER*

The chart here presented gives the value of the quantity $\sqrt{\frac{S+P}{S-P}}-1$ from the well-known formula of Lamé:

$$T = R\left(\sqrt{\frac{S+P}{S-P}}-1\right)$$

where T = thickness of cylinder wall in inches;
R = inside radius of cylinder in inches;
S = safe stress in pounds per square inch;
P = pressure in cylinder in pounds per square inch.

The figures at the left-hand side of the chart represent the pressure P in pounds per square inch, and the figures at the right-hand side represent the working stress S in the material in pounds per square inch. The figures at the bottom

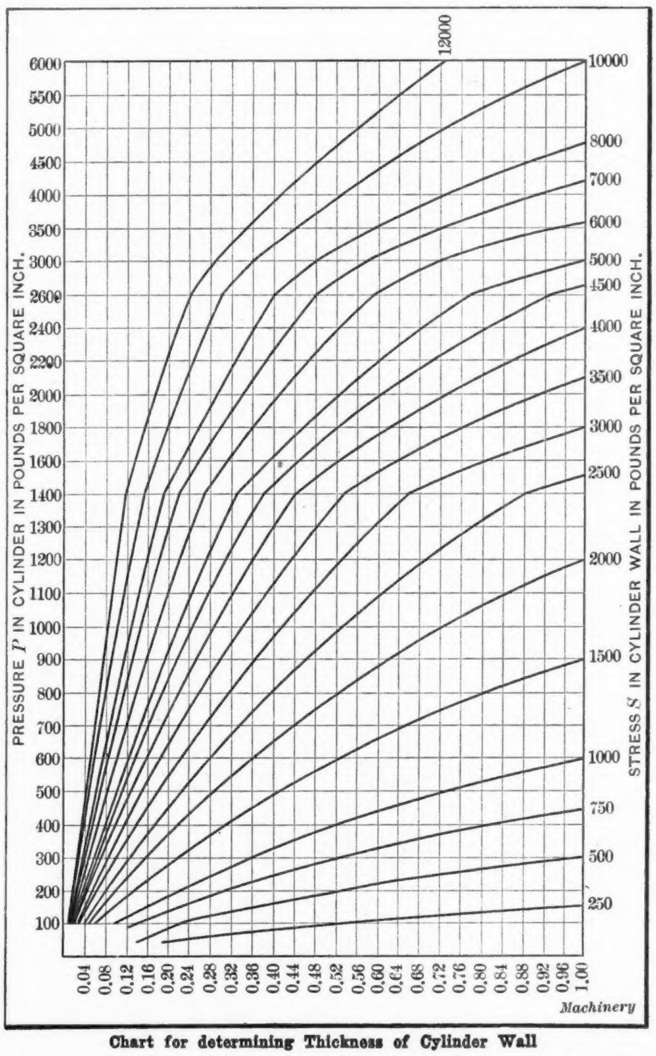

Chart for determining Thickness of Cylinder Wall

of the chart are constants for these two factors. In using the chart to determine the constant, the horizontal line through the proper pressure value is located, and the curve starting from the desired value of the stress is next found; this curve is then followed to the point where it intersects the horizontal pressure line, after which the vertical line is followed to the bottom of the chart to determine the constant. This constant multiplied by the inside radius R of the cylinder—which is a simple slide-rule operation—gives the required thickness T of the cylinder wall.

* * *

A process for preventing corrosion of iron and steel has been patented by H. Hanemann in England. The method makes use of dry ammonia gas. The objects to be treated are heated to about 1380 degrees F. and subjected to the action of a rapid stream of dry ammonia gas for about one and one-half hour, after which the furnace is allowed to cool slowly. By this means a protective layer of iron nitride (Fe_2N) is formed. It is stated that the nitrified iron is proof against atmospheric oxidation.

* Address: Fullerton, Pa.

FORMULAS FOR BLANK DIAMETERS OF DRAWN SHELLS

BY FRITZ J. W. SPARKUHL*

In the process of manufacturing drawing dies for round articles of fancy shape, the problem of finding the proper blank dimensions is of vital importance, and under ordinary

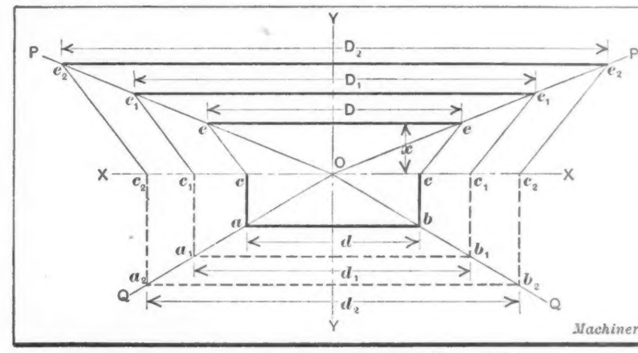

Fig. 1. Diagram illustrating Graphical Method of determining Blank Diameters for Shells of Proportional Sizes

conditions this is not the easiest task the diemaker or tool-designer has to face. As much time and labor are often spent in obtaining a satisfactory result, the writer has worked out a number of blank-formulas for the most common shapes, the vertical sections of which are shown in cases 1 to 28 in the accompanying tables.

These formulas are based upon the well-known and long-established rule that the area of the blank equals the area of the shell, or mathematically expressed:

$$\frac{\pi D^2}{4} = A$$

$$D = \sqrt{\frac{4}{\pi} \times A.}$$

where D = diameter of blank, and A = area of shell.

It is also assumed that the metal, which is comparatively thin, does not undergo any remarkable change of thickness while the flat blank is converted into a shell. In the third column of the tables the diameter of the blank is expressed in its most reduced and convenient form, and by substituting the proper dimensions these formulas will give the right results. All corners at the bottom are shown sharp, which is a condition that it is practically impossible to obtain in drawing dies, as the metal will not stand the strain. The radius of these corners should not be less than six to ten times the metal-thickness for tin plate and four to five times for copper plate, according to the quality. Otherwise, the tables are self-explanatory and no further comment is necessary.

In addition to these formulas an easy method is demonstrated for graphically determining the blank-dimensions of shells of different contents but similar forms, *i. e.*, shells whose lines are all proportional to each other, as shown in Figs. 1 and 2. The method consists of laying out the known shell section of diameter d, and by drawing the lines OQ through a and b we have the new shell sections $c_1a_1b_1c_1$ and $c_2a_2b_2c_2$, respectively, which are directly proportional to $cabc$. The method for determining the diameters of the

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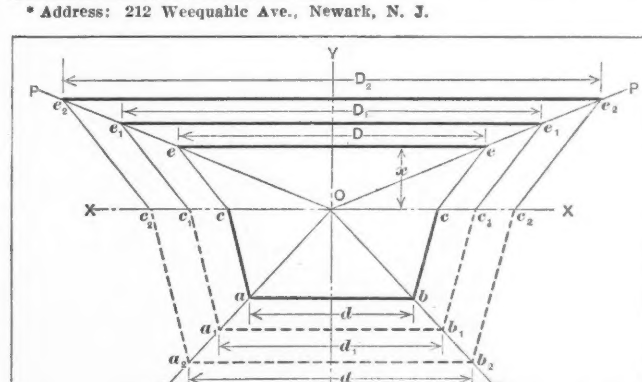
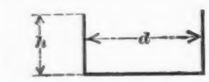
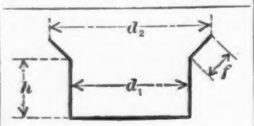
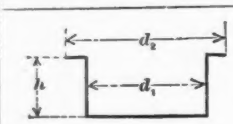
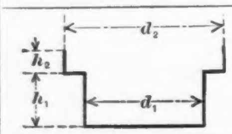
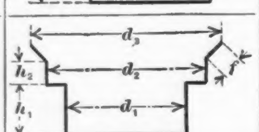
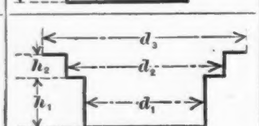
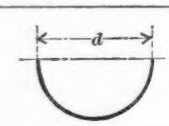
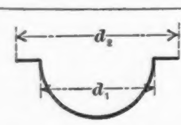
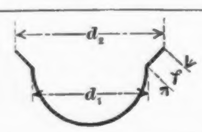
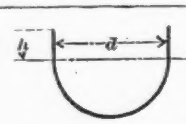
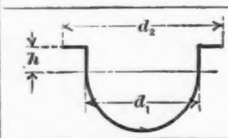
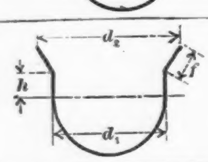
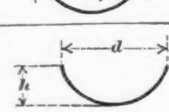
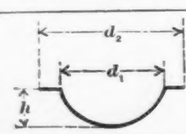
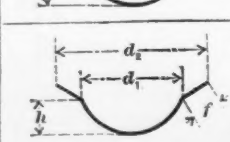


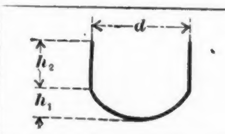
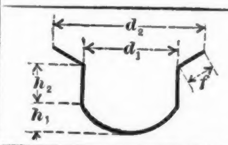
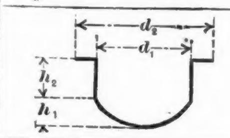
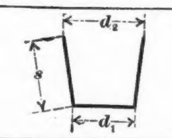
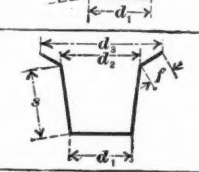
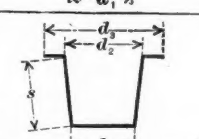
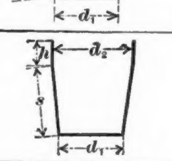
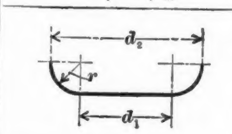
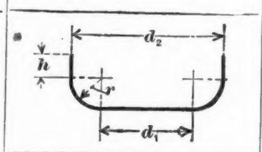
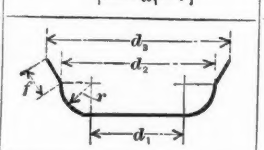
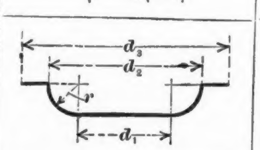
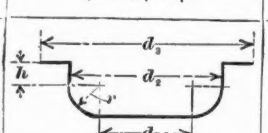
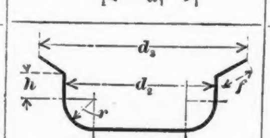
Fig. 2. Method illustrated in Fig. 1, applied to another Form of Shell

AREAS AND DIAMETERS OF BLANKS FOR DRAWN SHELLS

Fig.	Shape of Body	Area of Body A=	Diameter of Blank D=
1		$\frac{\pi d^2}{4} + \pi dh$	$\sqrt{d^2 + 4dh}$
2		$\frac{\pi d_1^2}{4} + \pi d_1 h + \pi f \frac{d_1 + d_2}{2}$	$\sqrt{d_1^2 + 4d_1 h + 2f(d_1 + d_2)}$
3		$\frac{\pi d_1^2}{4} + \pi d_1 h + \frac{\pi}{4}(d_2^2 - d_1^2)$	$\sqrt{d_1^2 + 4d_1 h + d_2^2 - d_1^2} = \sqrt{d_2^2 + 4d_1 h}$
4		$\frac{\pi d_1^2}{4} + \pi d_1 h_1 + \frac{\pi}{4}(d_2^2 - d_1^2) + \pi d_2 h_2$	$\sqrt{d_2^2 + 4(d_1 h_1 + d_2 h_2)}$
5		$\frac{\pi d_1^2}{4} + \pi d_1 h_1 + \frac{\pi}{4}(d_2^2 - d_1^2) + \pi d_2 h_2 + \pi f \frac{d_2 + d_3}{2}$	$\sqrt{d_2^2 + 4(d_1 h_1 + d_2 h_2) + 2f(d_2 + d_3)}$
6		$\frac{\pi d_1^2}{4} + \pi d_1 h_1 + \frac{\pi}{4}(d_2^2 - d_1^2) + \pi d_2 h_2 + \frac{\pi}{4}(d_3^2 - d_2^2)$	$\sqrt{d_3^2 + 4(d_1 h_1 + d_2 h_2)}$
7		$\frac{\pi d^2}{2}$	$\sqrt{2d^2} = 1.414d$
8		$\frac{\pi d_1^2}{2} + \frac{\pi}{4}(d_2^2 - d_1^2)$	$\sqrt{d_1^2 + d_2^2}$
9		$\frac{\pi d_1^2}{2} + \pi f \frac{d_2 + d_1}{2}$	$1.414\sqrt{d_1^2 + f(d_2 + d_1)}$
10		$\frac{\pi d^2}{2} + \pi dh$	$1.414\sqrt{d^2 + 2dh}$
11		$\frac{\pi d_1^2}{2} + \pi d_1 h + \frac{\pi}{4}(d_2^2 - d_1^2)$	$\sqrt{d_1^2 + d_2^2 + 4d_1 h}$
12		$\frac{\pi d_1^2}{2} + \pi d_1 h + \pi f \frac{d_1 + d_2}{2}$	$1.414\sqrt{d_1^2 + 2d_1 h + f(d_1 + d_2)}$
13		$\frac{\pi}{4}(d^2 + 4h^2)$	$\sqrt{d^2 + 4h^2}$
14		$\frac{\pi}{4}(d_1^2 + 4h^2) + \frac{\pi}{4}(d_2^2 - d_1^2)$	$\sqrt{d_2^2 + 4h^2}$
15		$\frac{\pi}{4}(d_1^2 + 4h^2) + \pi f \frac{d_1 + d_2}{2}$	$\sqrt{d_1^2 + 4h^2 + 2f(d_1 + d_2)}$

Machinery

AREAS AND DIAMETERS OF BLANKS FOR DRAWN SHELLS

Fig.	Shape of Body	Area of Body A=	Diameter of Blank D=
16		$\frac{\pi}{4}(d^2 + 4h_1^2) + \pi d h_2$	$\sqrt{d^2 + 4(h_1^2 + dh_2)}$
17		$\frac{\pi}{4}(d_1^2 + 4h_1^2) + \pi d_1 h_2 + \pi f \frac{d_1 + d_2}{2}$	$\sqrt{d_1^2 + 4\left[h_1^2 + d_1 h_2 + \frac{f}{2}(d_1 + d_2)\right]}$
18		$\frac{\pi}{4}(d_1^2 + 4h_1^2) + \pi d_1 h_2 + \frac{\pi}{4}(d_2^2 - d_1^2)$	$\sqrt{d_2^2 + 4(h_1^2 + d_1 h_2)}$
19		$\frac{\pi d_1^2}{4} + \pi s \frac{d_1 + d_2}{2}$	$\sqrt{d_1^2 + 2s(d_1 + d_2)}$
20		$\frac{\pi d_1^2}{4} + \pi s \frac{d_1 + d_2}{2} + \pi f \frac{d_2 + d_3}{2}$	$\sqrt{d_1^2 + 2[s(d_1 + d_2) + f(d_2 + d_3)]}$
21		$\frac{\pi d_1^2}{4} + \pi s \frac{d_1 + d_2}{2} + \frac{\pi}{4}(d_3^2 - d_2^2)$	$\sqrt{d_1^2 + 2s(d_1 + d_2) + d_3^2 - d_2^2}$
22		$\frac{\pi d_1^2}{4} + \pi s \frac{d_1 + d_2}{2} + \pi d_2 h$	$\sqrt{d_1^2 + 2[s(d_1 + d_2) + 2d_2 h]}$
23		$\frac{\pi d_1^2}{4} + \frac{\pi^2 r}{2}(d_1 + 1.274r)$; or $\frac{\pi}{4}(d_2 - 2r)^2 + \frac{\pi^2 r}{2}(d_2 - 0.726r)$	$\sqrt{d_1^2 + 6.28rd_1 + 8r^2}$; or $\sqrt{d_2^2 + 2.28rd_2 - 0.56r^2}$
24		$\frac{\pi d^2}{4} + \frac{\pi^2 r}{2}(d_1 + 1.274r) + \pi h d_2$; or $\frac{\pi}{4}(d_2 - 2r)^2 + \frac{\pi^2 r}{2}(d_2 - 0.726r) + \pi h d_2$	$\sqrt{d_1^2 + 4(1.57rd_1 + 2r^2 + hd_2)}$; or $\sqrt{d_2^2 + 4d_2(h + 0.57r) - 0.56r^2}$
25		$\frac{\pi}{4}d_1^2 + \frac{\pi^2 r}{2}(d_1 + 1.274r) + \pi f \frac{d_2 + d_3}{2}$; or $\frac{\pi}{4}(d_2 - 2r)^2 + \frac{\pi^2 r}{2}(d_2 - 0.726r) + \pi f \frac{d_2 + d_3}{2}$	$\sqrt{d_1^2 + 6.28rd_1 + 8r^2 + 2f(d_2 + d_3)}$; or $\sqrt{d_2^2 + 2.28rd_2 + 2f(d_2 + d_3) - 0.56r^2}$
26		$\frac{\pi d_1^2}{4} + \frac{\pi^2 r}{2}(d_1 + 1.274r) + \frac{\pi}{4}(d_3^2 - d_2^2)$; or $\frac{\pi}{4}(d_2 - 2r)^2 + \frac{\pi^2 r}{2}(d_2 - 0.726r) + \frac{\pi}{4}(d_3^2 - d_2^2)$	$\sqrt{d_1^2 + 6.28rd_1 + 8r^2 + d_3^2 - d_2^2}$; or $\sqrt{d_3^2 + 2.28rd_2 - 0.56r^2}$
27		$\frac{\pi d_1^2}{4} + \frac{\pi^2 r}{2}(d_1 + 1.274r) + \pi d_2 h + \frac{\pi}{4}(d_3^2 - d_2^2)$; or $\frac{\pi}{4}(d_2 - 2r)^2 + \frac{\pi^2 r}{2}(d_2 - 0.726r) + \pi d_2 h + \frac{\pi}{4}(d_3^2 - d_2^2)$	$\sqrt{d_1^2 + 6.28rd_1 + 8r^2 + 4d_2h + d_3^2 - d_2^2}$; or $\sqrt{d_3^2 + 4d_2(0.57r + h) - 0.56r^2}$
28		$\frac{\pi d_1^2}{4} + \frac{\pi^2 r}{2}(d_1 + 1.274r) + \pi d_2 h + \pi f \frac{d_3 + d_2}{2}$; or $\frac{\pi}{4}(d_2 - 2r)^2 + \frac{\pi^2 r}{2}(d_2 - 0.726r) + \pi d_2 h + \pi f \frac{d_3 + d_2}{2}$	$\sqrt{d_1^2 + 6.28rd_1 + 8r^2 + 4d_2h + 2f(d_2 + d_3)}$; or $\sqrt{d_2^2 + 4d_2\left(0.57r + h + \frac{f}{2}\right) + 2d_3 f - 0.56r^2}$

Machinery

blanks D_1 and D_2 is based on the geometrical theorem that the areas of similar bodies are proportional to the square of corresponding lines of these bodies.

Let A = area of given shell;

d = diameter of given shell;

D = blank diameter of this shell;

d_1, d_2, etc., = diameters of unknown shells;

A_1, A_2, etc., = areas of these shells;

D_1, D_2, etc., = blank diameters of unknown shells.

The preceding theorem for determining the required blank diameters may be expressed:

$$\frac{A}{A_1} = \frac{d^2}{d_1^2}, \quad \frac{A}{A_2} = \frac{d^2}{d_2^2}, \text{ etc., or}$$

$$\sqrt{\frac{A}{A_1}} = \frac{d}{d_1}, \quad \sqrt{\frac{A}{A_2}} = \frac{d}{d_2}, \text{ etc.}$$

We know that the area of the blank equals the area of the shell. Expressed in the form of equations:

$$D = \sqrt{\frac{4}{\pi} \times A}, \quad D_1 = \sqrt{\frac{4}{\pi} \times A_1}, \quad D_2 = \sqrt{\frac{4}{\pi} \times A_2}, \text{ etc.}$$

$$\text{Therefore } \sqrt{\frac{\pi/4 \times A}{\pi/4 \times A_1}} = \frac{d}{d_1} = \frac{D}{D_1}, \quad \sqrt{\frac{\pi/4 \times A}{\pi/4 \times A_2}} = \frac{d}{d_2} = \frac{D}{D_2}, \text{ etc.}$$

In plain words, the blank diameters of similar shells are proportional to any corresponding diameters of these shells. To find D_1, D_2, etc., graphically, we proceed as follows: The known blank diameter *ee* of shell *d* is laid out parallel to the horizontal axis *X-X* at any distance *x*, and bisected by the vertical axis *Y-Y*. We next draw lines *OP* from *O* through the points *e* and connect points *c* with points *e*. We then draw parallels to lines *ce* from points c_1, c_2, etc., to lines *OP* which intersect at e_1, e_2, etc. By connecting points e_1e_1, e_2e_2, etc., we have the desired diameters D_1, D_2, etc., for shells of diameters d_1, d_2, etc.

Another idea which might be appreciated is the following: In case a full set of shells has to be drawn and all dimensions have to be in direct proportion to each other, when one shell is given and its blank diameter and cubic contents are known, we use the stereometrical theorem:

The contents of similar bodies are proportional to the cubes of their corresponding lines, *i. e.*:

$$\frac{V}{V_1} = \frac{d^3}{d_1^3}, \quad \frac{V}{V_2} = \frac{d^3}{d_2^3}, \text{ etc., or } \sqrt[3]{\frac{V}{V_1}} = \frac{d}{d_1}, \sqrt[3]{\frac{V}{V_2}} = \frac{d}{d_2}, \text{ etc.}$$

We saw that $\frac{d}{d_1} = \frac{D}{D_1}$; therefore $\frac{D}{D_1} = \sqrt[3]{\frac{V}{V_1}}$.

As D_1 has to be found:

$$D_1 = D \times \sqrt[3]{\frac{V_1}{V}} \quad D_2 = D \times \sqrt[3]{\frac{V_2}{V}}, \text{ etc.}$$

The preceding is a formula which I found useful when I had to design tools for a set of eight round tomato boxes of different contents but similar form, and I think that anybody using these methods will find them most valuable time- and trouble-savers.

* * *

DECLARATION OF SANITARY PRINCIPLES

The Board of Sanitary Control of the Cloak and Suit Industry in New York City has formulated a set of principles which mark a radical departure from the recognized and accepted standards that have prevailed in industrial life since the rise and growth of the modern factory system. They apply generally to conditions of factory life, and are reproduced herewith.

1. An industry is responsible for the conditions existing in its establishment.
2. It is the duty of an industry to control, supervise and improve the sanitary conditions of its industrial establishments without compulsion from outside sources.
3. The general public is directly and intensely interested in the sanitary conditions existing in industry.
4. Decent sanitary conditions of the workshops are the first requisites and a debt which manufacturers in the industry owe to the public and to the workers.
5. An efficient and permanent improvement in the conditions of industrial establishments can only be brought about by the efforts and by the cooperation of the manufacturers, of the public and of the workers themselves.

* * *

A peculiar characteristic of metal alloys is that the electrical conductivity of a metal is often very much decreased by alloying it with another metal. As an example it may be mentioned that an alloy of gold and silver will have less electrical conductivity than either of the metals from which it is formed. Another peculiar property of alloys is that when a pure metal is cooled to a very low temperature, its electrical conductivity is greatly increased, but this is not the case with an alloy.

EXPERIENCES OF AN APPRENTICE

BY APPRENTICE

Gee, but I got a real call-down this morning from the boss, and for a time I didn't know whether to throw up the job or stick. Now, as I look back on it, I realize that it was only because he wanted to show me where I was wrong. But it certainly hurt my pride to be called down in front of the whole room.

The trouble came from a job the boss gave me several days ago—a jig having seventeen holes unequally spaced. After machining the casting, I strapped it to an angle-plate on the milling machine and spotted all the holes, then drilled and bored them. The job was done in pretty good time, and I turned it over to the boss for inspection with a touch of pride, thinking that I had managed to finish this particular job without leaving a "trade-mark" of any kind on it.

On inspection, the boss soon discovered errors of 0.002 to 0.003 inch in center distances between some of the holes and 0.037 inch error between the last two holes. He called me to the milling machine and said:

"I want you to start from the center of the jig, or from whatever point you did start from, and show me just how you moved the table and knee when you bored those holes."

There was something about the way he talked and acted that made me suspect that all was not well. But I showed him how I started the job and began to explain how I bored the hole and so on. But he interrupted me with:

"Just take hold of the handle and let me see you go through the actual operation from one hole to the next."

I started from an imaginary point, set the dials on the feed-screws, moved the table along to the last hole, and went through the seemingly foolish operation of feeding the table crosswise to bore an imaginary hole. Then the table was moved in the opposite direction ¼ inch, which was the distance to the next hole and it happened to be one complete revolution of the dial. The boss stopped me right there and said:

"You have worked at this business over three years and yet you don't know enough to take up the backlash in the screw. You moved the table in one direction, bored a hole and then started right back and bored the next hole. Don't you know that the screw has a certain amount of backlash that allows the dial to rotate 0.030 or 0.040 inch before the table starts to move?"

I knew it all right but through lack of care and foresight it never entered my mind when doing the job. Well, after the boss got a lot of unprintable words out of his system, he became thoughtful and said:

"What puzzles me is how you made a mistake of 0.003 and 0.004 inch between the holes, because the screws in that milling machine were especially made for jig work and we use them for nothing else. Let me see you move the table to bore the next hole."

Now it happened that the next hole was at an odd dimension from the other and the dial stopped at 75. I moved the table the required distance and then loosened the dial and swung it around until the zeros lined up and right there I received another call-down. I will not repeat it word for word, but the substance of it was never to move the dials from the time they are first set to the finish of the job, and to go far enough beyond the required reading on the dial in each case to take up the backlash before the required reading on the dial coincides with the zero on the machine.

I could not understand why there would be discrepancies in the center distances of the holes because of moving the dial, as long as the desired line on the dial was set exactly with the line on the machine. Tom stopped his shaper and took the time to show me how easy it was to move the handle while loosening the dial. The fellow that said "experience is a bitter teacher" knew what he was talking about, and while I'll never make that mistake again, I wish that I had learned it either by reading or by being told in a quiet way instead of being called down before all the boys.

* * *

It is said that among the various materials used for cleaning files, a piece of coke gives as good results as any.

MACHINING MOTOR CYCLE PARTS*

MISCELLANEOUS MACHINING OPERATIONS ON MOTOR CYCLE CYLINDERS, PISTONS, PISTON RINGS AND FLYWHEELS

BY DOUGLAS T. HAMILTON†

Fig. 1. First Machining Operation on a Motor Cycle Cylinder Casting—Boring the Cylinder and turning the Neck

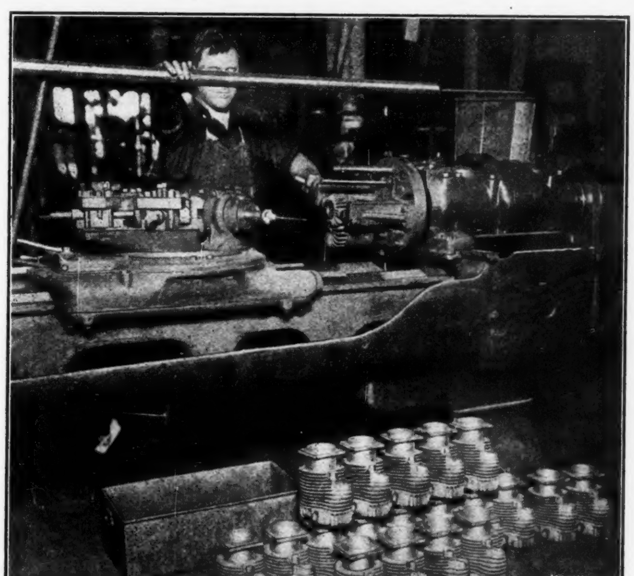


Fig. 2. Second Operation on a Motor Cycle Cylinder Casting—Machining the Inlet and Exhaust Valve Holes

In machining motor cycle cylinder castings, pistons, piston rings and flywheels, the Harley-Davidson Motor Co., Milwaukee, Wis., makes good use of the Jones & Lamson flat turret lathe. This type of machine is particularly adapted to work of this kind because of the cross-sliding head which offers many advantages. This will be particularly noticeable in the machining of the inlet and exhaust valve holes in the head of the cylinder casting, in the machining of pistons and also of piston rings. The Harley-Davidson Motor Co. has developed a number of interesting fixtures for handling this work, and the tool equipment is worthy of special note. There are, of course, additional operations on motor cycle cylinders, such as milling and grinding, which while not altogether out of the ordinary, present some features of interest. Where a large production is necessary, simple but efficient fixtures and tool equipment must be evolved so that the work can be handled quickly and accurately. In the following article a number of the most interesting features in the making of motor cycle engine parts will be illustrated and described.

First Operation on the Motor Cycle Cylinder Casting

Motor cycle cylinder castings for Harley-Davidson motor cycles are cast singly, and the first operation on this type of casting consists in machining the cylinder bore and neck and

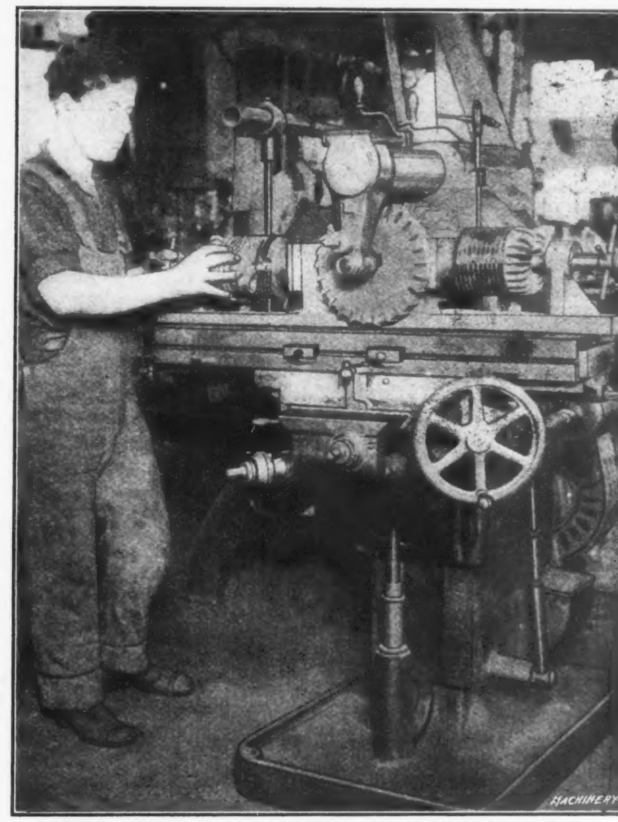


Fig. 3. Milling the Bases of Motor Cycle Cylinder Castings on a Fixture of the Reciprocal Type

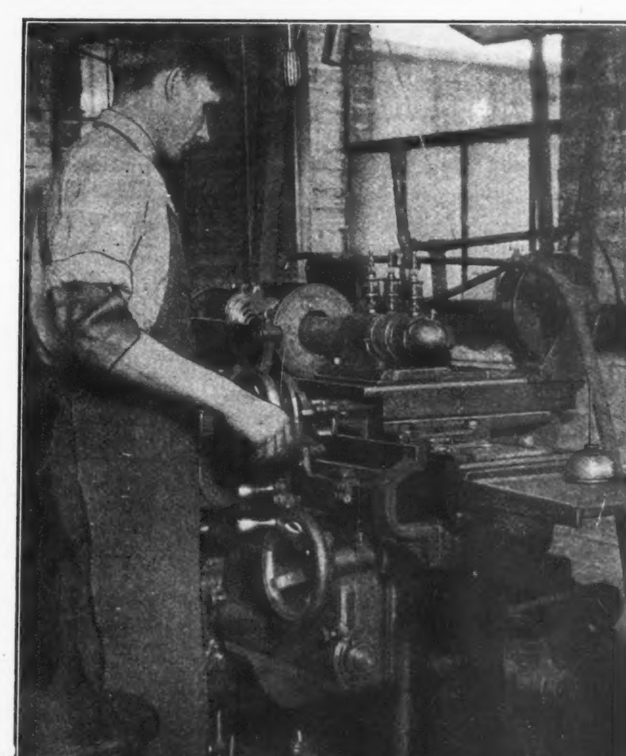


Fig. 4. Grinding Motor Cycle Cylinder Bores

* For information on this and kindred subjects, see "Production Tools for Reo Engine Cylinders" in the August and September, 1914, numbers of MACHINERY.

† Associate Editor of MACHINERY.

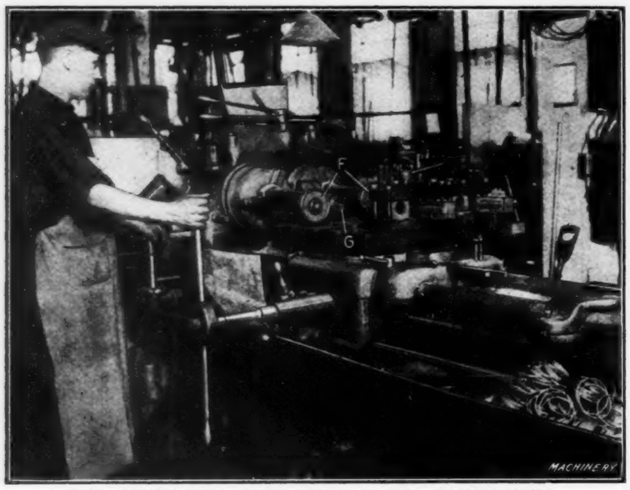


Fig. 5. Machining Piston Rings on the Double-spindle, Flat Turret Lathe

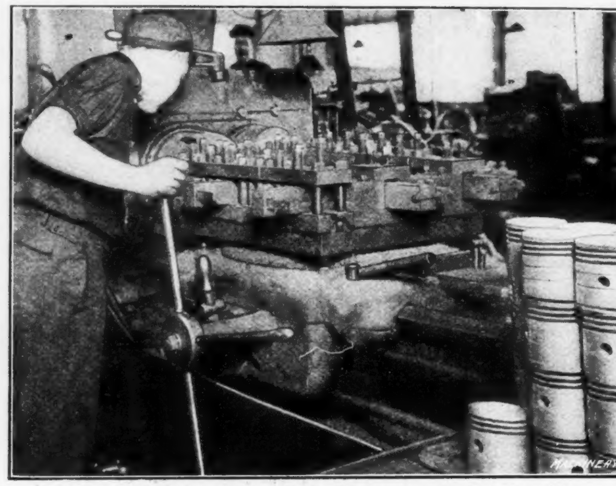


Fig. 6. Machining Motor Cycle Pistons on the Double-spindle Flat Turret Lathe

facing the flange and end. These operations are handled on a single-spindle three-inch flat turret lathe. As shown in Fig. 1, the casting is held in a special chuck screwed onto the nose of the spindle. This chuck has two projecting lugs, which add to the support of the casting around the water jacket housing. The first operation is to rough-bore the cylinder, which in the rough is 3 1/16 inches in diameter by 7 inches deep. Two roughing cuts are first taken, the cross-sliding head being moved over the required amount to take the two cuts and finishing the bore to 3 3/16 inches in diameter. About ¼ inch of metal on the diameter is removed from the bore of the cylinder. After boring, the neck is turned to 3⅝ inches in diameter by 2 inches long, and the end of the cylinder and flange are faced. For these operations the cross-sliding head also comes into play. The flange, of course, is faced on both the front and rear sides to the thickness desired. In all there are about ten separate operations, and it is possible to obtain a production of thirty-five castings in ten hours from one machine.

Second Operation on the Motor Cycle Cylinder Casting

The second series of operations on the motor cycle cylinder casting which consists in machining the inlet and exhaust valve holes in the head of the casting is also performed on a single-spindle flat turret lathe. A special fixture, as shown in Fig. 2, is fastened to a faceplate, the latter being screwed onto the nose of the spindle. This fixture comprises two arms carrying clamping bolts, one of which is provided with a check-nut and the other with a handle, so that when the fixture has once been set for the casting it is not necessary to change the position of the second clamping bolt when replacing or removing a piece. The operator only loosens the handle clamping bolt and in this way releases the work, after the toe-clamps fastening the base of the cylinder casting to the fixture have been released. The casting is located from the previously machined bore by a boss on the faceplate.

In all, there are eleven tools used for performing the series of operations on the inlet and exhaust valve holes. The operations take the following order: First, two rough-boring cuts are taken from the exhaust valve hole and chamber, after which the chamber is faced and counterbored. A smaller hole 9/32 inch in diameter is then drilled and reamed to 5/16 inch diameter, this being located at the bottom of the chamber. Two counterbored portions are then machined 5/16 and 3/8 inch diameter, respectively, 1⅛ inch deep. Following the machining of the exhaust valve hole, the fixture is indexed around to bring the inlet holes in line, and these are then machined. The operations on the inlet valve holes are somewhat similar to those performed on the exhaust valve hole, with the exception that the hole is tapped. The operations enumerated in their proper order are: boring, reaming, recessing and tapping. The cross-sliding head makes possible a considerable production on this job, which requires two different settings. The work is not shifted after it is once placed and clamped in the fixture until it is completely machined, any difference in position being taken care of by the cross-sliding head. The production on this job from one machine is sixty completed cylinder castings in ten hours.

Milling Cylinder Casting Bases

After the machining of the cylinder bores and the inlet and exhaust valve holes, the castings are taken to a drill press and four holes are drilled in the flange of the cylinder casting for clamping it to the crank-case; these holes are also utilized in successive operations as locating points. The next important operation is the milling of the cylinder casting base. This is performed as shown in Fig. 3 on a No. 1-A Kearney & Trecker milling machine, and the operations consist in squaring all four sides of the flange. The castings are held on a fixture of the reciprocal milling type, so that while the cutters are working on one casting, the operator is putting a new piece in the other end of the fixture.

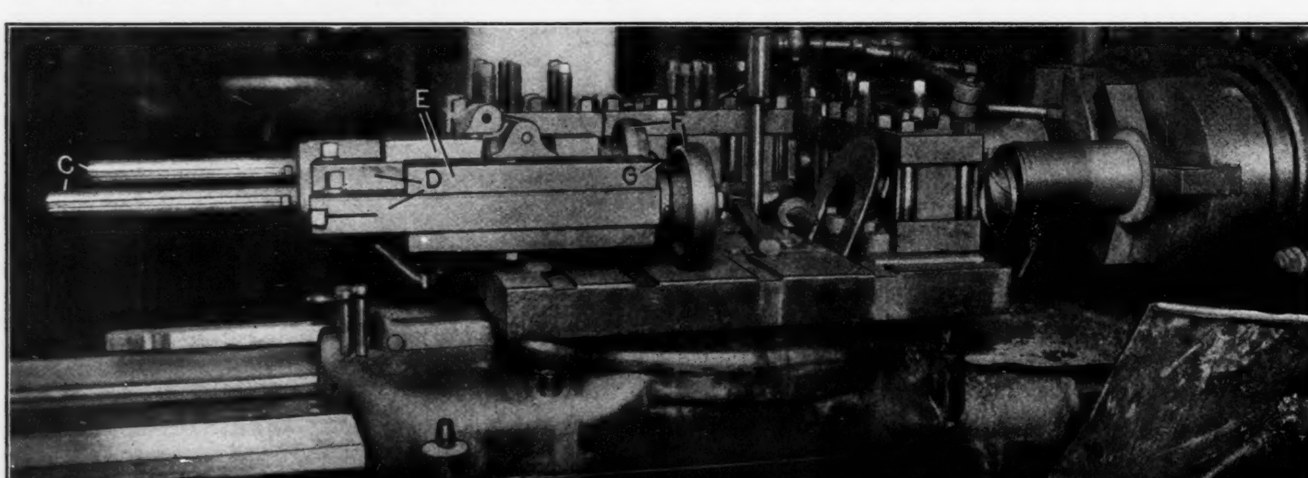


Fig. 7. Close View of Machine in Fig. 5, showing Method of driving the Cam Rolls for securing the Eccentricity on the External Diameter of the Rings

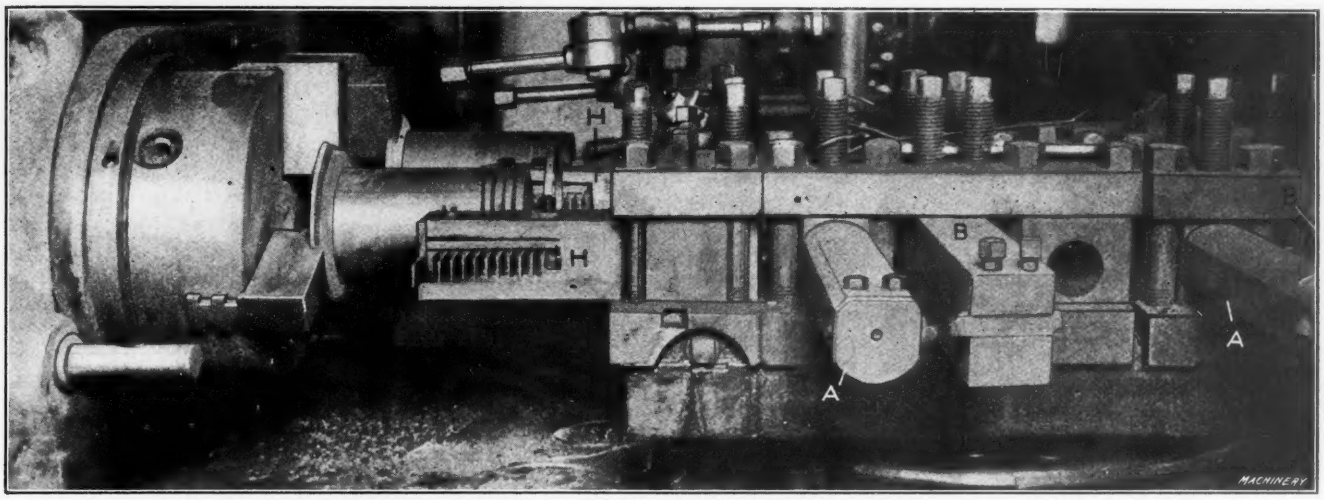


Fig. 8. Close View of Machine shown in Fig. 5, showing the Cutting-off Tools at Work cutting off the Piston Rings

In operation, the castings are located from the four previously drilled holes in the flange which fit locating plugs on the fixture. The castings are held tight up against the fixture by screw clamps, one of which is located in each end of the fixture, and clamps the casting by entering the inlet valve chamber. Two milling cutters 10 inches in diameter having high-speed steel inserted blades 1¼ inch wide are used for machining the flange of the cylinder casting. One-eighth inch of material on each side of the flange is removed, the flange being finished to 3 15/16 inches square by 3/8 inch wide. As this fixture is not provided with any indexing mechanism, it is necessary for the operator to unclamp each casting twice before it is finish-machined, and turn it around to present the two opposing sides to the milling cutters. The machine can work practically continuously, however, as one casting can be changed while the cutters are at work on another. The production on this job is 300 finished cylinder castings in ten hours.

Grinding the Cylinder Bore

The grinding of the cylinder bore is accomplished on a Heald internal grinding machine. A special fixture of the cradle type is used for holding the castings while grinding. This fixture, as shown in Fig. 4, comprises a faceplate screwed onto the nose of the spindle that ordinarily carries the chuck, and by means of extension arms carries an additional faceplate, providing means for locating and clamping the casting. The cylinder casting is held parallel with the travel of the internal grinding head, and is located from the flange at the base of the casting. The amount of material removed from the diameter of the cylinder by grinding varies from 0.006 to 0.010 inch on the diameter, the finished diameter being 3.310 and the limit 0.0005 inch on the diameter. The depth of the bore is 7 inches. The practice is to take one roughing cut and two finishing cuts from the cylinder bore. A special Norton No. 3033 grinding wheel ¾ inch wide by 3 inches in diameter is used, which is rotated at 6800 R. P. M. The work is rotated at about 100 R. P. M. for the rough-grinding cut and at 150 R. P. M. for finishing. The production from one machine is thirty-eight completed cylinder castings in ten hours.

Machining Piston Rings

The tool equipment used on the double-spindle flat turret lathe for machining piston rings comprises a number of interesting features. The piston rings are made from a casting which in the rough is 6 3/4 inches long by 3 9/16 inches outside diameter. As shown in Figs. 5 and 7, two of these castings are held in three-jawed chucks, which are screwed onto the two spindles of the machine. The operations consist in first rough-boring and rough-turning the internal and external diameters of this casting, both operations being handled at the same time. As shown in Fig. 8, the internal and external diameters are bored and turned by tools *A* and *B* securely clamped to the flat turret, as illustrated.

After taking a cut of about 1/16 inch from the external and internal diameters of the casting, the turret is indexed, bringing the finish-boring and turning tools into position. These tools comprise the most interesting part of the tool equipment, and are shown in detail in Fig. 7. The internal boring tool is held in the boring-bars *C*, whereas the external cutting tools are held in tool-holders *D*.

The boring-bars *C* are provided with a keyway and fit a keyed bushing in the spindle of the machine, so that these bars are rotated when in action on the work. The fixtures *E* carrying the external turning tool-holders are set off to one side of the boring-bars, and carry rolls *F* which mesh with eccentric cam rolls *G*, the latter being fastened to the boring-bars *C* which extend through the fixture. Rolls *F* have a circular form and are utilized as a means for transferring an oscillating movement to the tool-holders *D*, the latter being fulcrumed on a pin in the holder *E*. The holders *D*, in addition to being fulcrumed, are also backed up with springs which keep the rolls *F* in contact with the eccentric cam rolls *G*, thus providing for the required eccentric movement to the external cutting tool-holders.

The eccentric cam rolls *G* carry a mark which corresponds to the thinnest part of the piston ring, and when this mark is in line with the external tool the finish-turning operations are completed, and the operator stops the spindle, brings this mark in line with the turning tools and then withdraws the

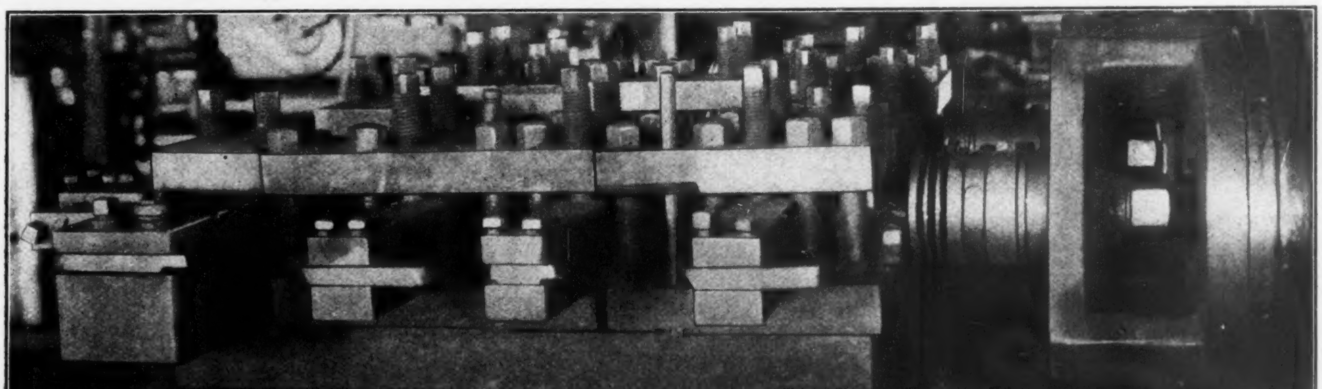


Fig. 9. Tool Set-up used for machining Motor Cycle Pistons on a Double-spindle Flat Turret Lathe

turret. The turning tools in being drawn straight back produce a longitudinal mark on the piston ring castings, which is used in a subsequent operation as a guide for slitting the rings.

After finish-boring and turning, the turret is again indexed and the cutting-off tools are brought into position. As shown in Fig. 8, the cutting-off tool-holders *H* carry twelve blades, each successive one, starting from the turret to the chuck, being set out a little farther, so that the cutting off of the rings is accomplished progressively. This tool-holder cuts off thirteen rings in the first setting, and after the completion of the last ring, the turret is advanced toward the chuck and another series of rings severed from the casting, twenty-one rings being cut from each casting, and as two castings are held in the machine and machined at one time, twice this number or forty-two piston rings are completed at each chucking. It is therefore evident that the production from this machine is high, which it is, averaging a thousand piston rings in ten hours.

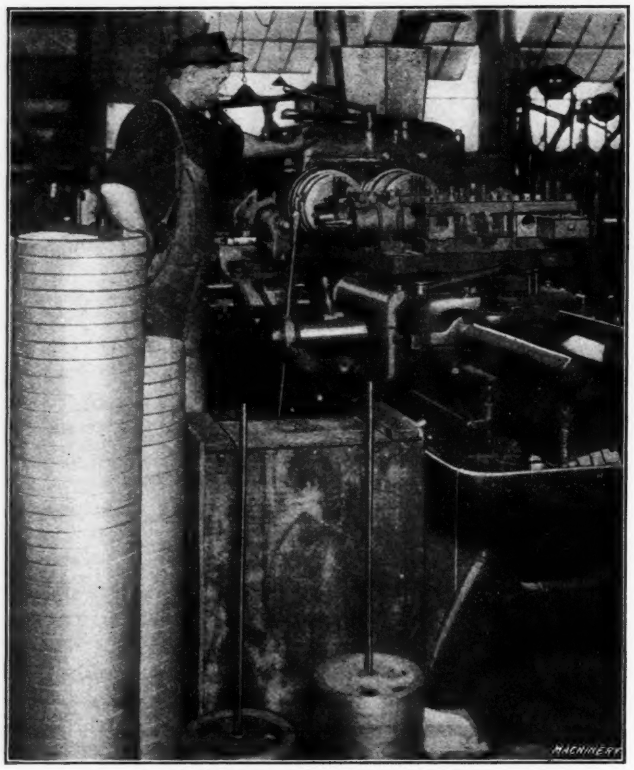


Fig. 10. Machining a Motor Cycle Flywheel on the Double-spindle Flat Turret Lathe

Machining Motor Cycle Pistons

Pistons for Harley-Davidson motor cycle engines are also machined on double-spindle flat turret lathes as shown in Fig. 6. Two piston castings are machined at one time, being held on the special fixtures shown in Fig. 9. These fixtures comprise a double faceplate screwed onto the nose of the spindle, and carrying clamping bolts in their forward ends. These clamping bolts hold the pistons up tight against the machined faces of the fixtures by means of pins passing through the connecting-rod pin holes in the piston castings. The first operation is to rough-turn the external diameter of the piston, two cutters being used for this purpose, one working on each side of the piece, as shown in Fig. 9. The second operation is to rough-groove for the piston rings, of which there are three, machine one oil-groove and one clearance-groove, and rough-face the end of the piston, all these operations being handled simultaneously by tools in the turret. The third operation is to finish the piston ring, oil and clearance grooves and also finish-face the end, whereas, the fourth operation is to take a final finishing cut from the external diameter of the pistons, finishing them to 3 5/16 inches diameter by 3½ inches long and removing about ⅛ inch of material all around.

There is one point about the machining of these pistons that should not be overlooked. The diameter of the piston ring groove is only 3 1/64 inches, leaving a wall on the piston of only 1/16 inch all around. This makes a rather difficult machining proposition because of the fact that the casting springs considerably if a cut of any depth is taken. It is therefore necessary for the operator to go slow, in machining, and to facilitate the roughing, the casting is supported by a cutting tool on each side. The same tool set-up is also used for taking the final cut so that any tendency of the casting to spring out of shape is minimized. In spite of the fact that the work must be handled with care, 130 pistons are finished in each machine in ten hours.

Machining Motor Cycle Flywheels

Another interesting operation performed on double-spindle flat turret lathes is the machining of motor cycle flywheels, two being held at one time in the two chucks fastened to the spindles of the machine. Fig. 10 shows one of the double-spindle flat turret lathes at work on flywheels, whereas Fig. 11 gives a closer and better view of the tool set-up. The flywheel is finished to 9 inches outside diameter, and has a width of rim of 1 3/32 inch. The first operation consists in facing the flange and hub; the second, in turning the rim and drilling the hole at the same time; the third in back-facing the flange and breaking the corners; and the fourth in taper reaming the hole which has already been drilled. The taper on the reamer is 6 inches to the foot. This flywheel is machined all over with the exception of the rear hub, the depth of which is ⅞ inch. The production is 140 flywheels in ten hours.

In the preceding examples, the advantage of the cross-sliding head is clearly indicated. In many instances production has been greatly increased by its use, and it also adds to the accuracy of the work, because the position of the head for each consecutive operation is definitely set by means of stops, interchangeable manufacture thus being possible.

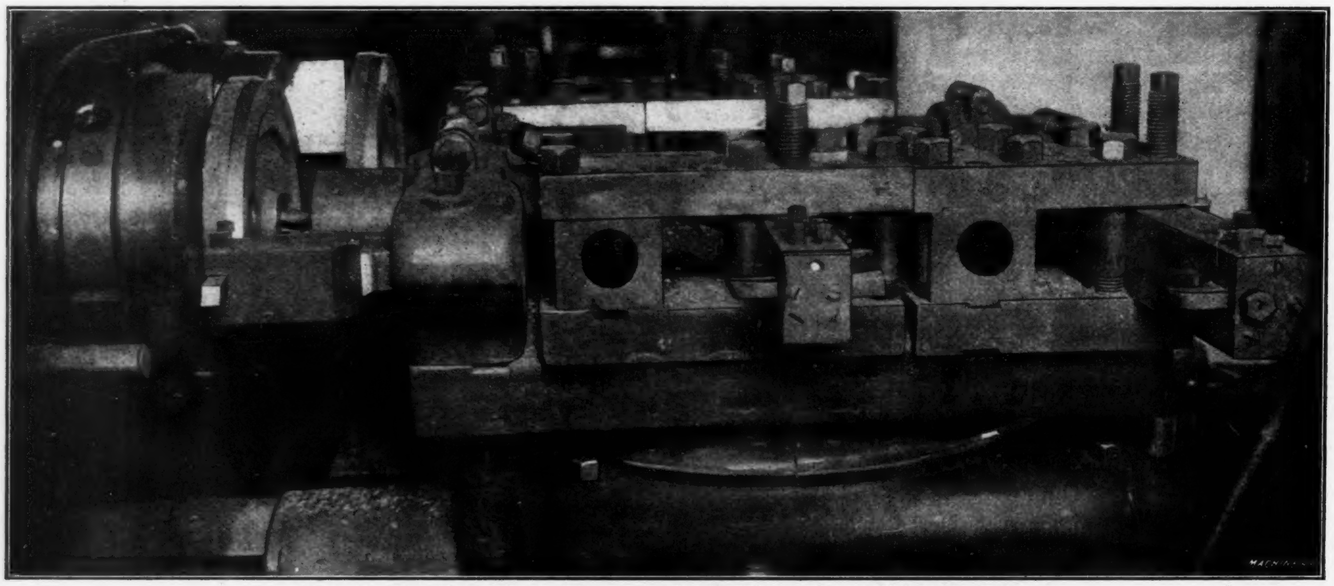


Fig. 11. View of Machine in Fig. 10, showing Tool Set-up for machining Flywheels

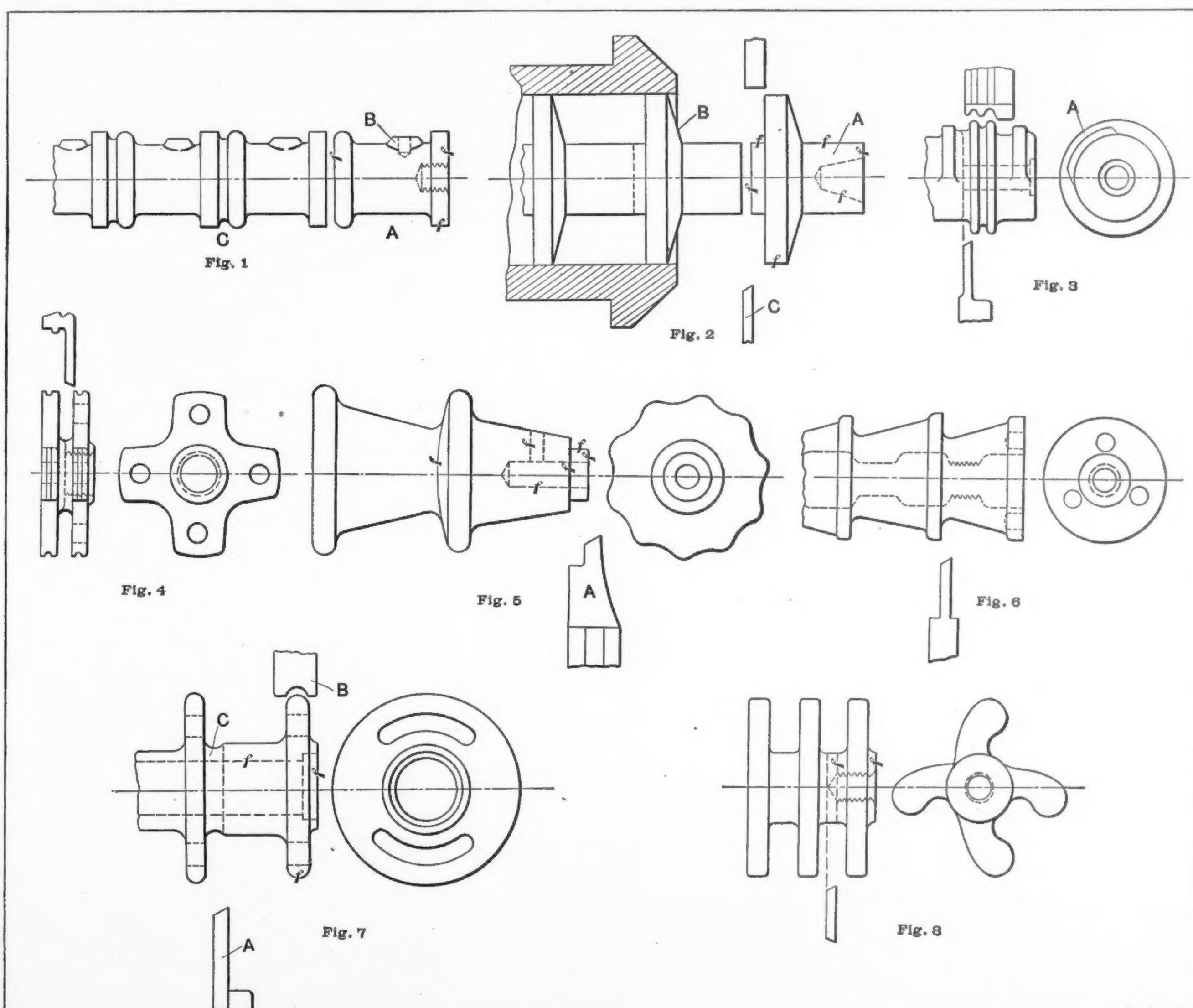
MACHINING CASTINGS IN THE AUTOMATIC SCREW MACHINE

HOW WORK IS CAST TO ENABLE IT TO BE FINISHED ON THE "AUTOMATIC"

BY E. WHITNEY

THE machining of cylindrical cast metal parts is usually performed in the turret lathe or semi-automatic machines. The hand turret lathe requires an operator for each machine, while the semi-automatic machines of the single-chuck type require considerable time to load the work. A few manufacturers have saved considerable expense in machining round parts to be made of cast metal by casting them in bars from 4 to 6 feet in length according to the length of the piece, and finishing them automatically in one of the different forms of screw machines, the same as in handling bar stock. An important feature of this method is the use of the various attachments which belong to the automatic machines. The most success has been found in machining brass parts although the harder metals including cast iron may also be machined successfully. The piece shown at *A* in Fig. 1 is being manufactured in large quantities from hard brass cast in five-foot lengths which carry thirty pieces to one bar. The first advantage gained by using this method is in finishing the piece at both ends without rechucking, as would be necessary in the usual type of hand machine. The ends and the diameter at one end are finished by the cut-off tool when separating the piece from the bar. The boss shown at *B* justifies the piece being made in the manner described; otherwise it should be made from bar stock. The hole in the boss is drilled by the cross-drilling attachment. The way in which these parts are cast in one unit is shown at *C*. It is well to note that bars should not be cast in lengths of more than 5 or 6 feet, as there is danger of warping when the metal cools; also, work which is less than 1 inch in diameter should not be machined in this manner for the same reason.

Fig. 2 shows the kind of work which will allow the greatest saving when machined from bars of cast metal. The length of the bar for this piece was 4½ feet and contained sixteen parts. As the piece was required to be finished all over, it was first made from cold-rolled steel bars which proved to be expensive owing to the waste of metal and time in turning the stem; and as the material could be cast iron as well as steel, it was made in single castings and machined in a hand turret lathe. This method, however, required two operations, as the piece was finished on both ends, and also because the hole was required to line up with the large diameter. The order of operations was as follows: 1. Chuck the work on the extension *A*. 2. Face the end and shoulder, and turn the small diameter and outside diameter. 3. Turn the piece end for end and chuck it on the outside diameter. 4. Center, drill, face and ream the tapered hole. The weak point in the preceding order of operations is in No. 3 because the large diameter is not of sufficient width to secure a good purchase for the chuck jaws. By machining this piece in the automatic screw machine from a cast bar these objections were overcome, and the piece was also finished complete with one setting of the machine. The way in which the cast bar is carried in the chuck is illustrated at *B*, and the cut-off tool is shown at *C*.



Figs. 1 to 8. Examples of Various Types of Castings which are machined in Automatic Screw Machines

The work shown in Fig. 3 has a cam cast on each piece as shown at *A*. This cam later receives a file finish. The work is machined in the manner described for the other pieces and is separated from the bar by the cut-off tool, as shown. A saving was also made on this piece because the length of the cam varied from 30 degrees to 270 degrees, which required the use of four different chucks on the hand machine, whereas on the automatic machines the length of the cams did not affect the holding of the work. The base-plate shown in Fig. 4 is made of cast brass and was formerly turned and tapped on the engine lathe, after which the holes were drilled in the drill press. A saving of 200 per cent was made when this piece was cast in bars and machined in the automatic screw machine. This exceptional saving was not only due to the

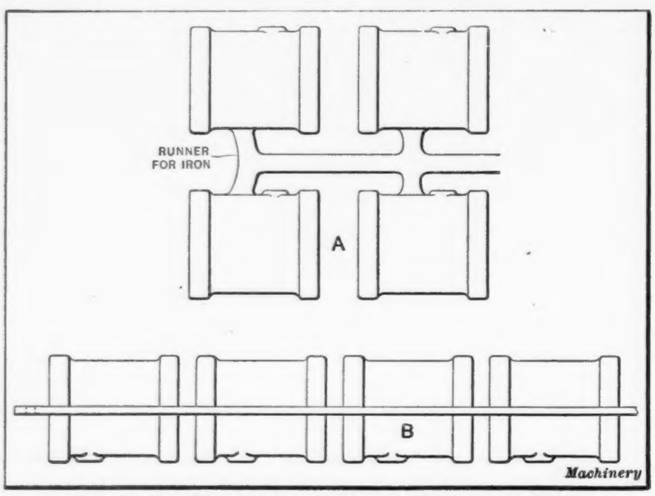


Fig. 9. Two Methods of arranging the Pattern and Mold for the Same Piece

automatic performance of the turning and threading operations, but also to the use of a special cross-slide drilling attachment, which is not the usual cross drill but comprises a drill that is fed longitudinally. This has been previously described in these columns as well as the method of indexing the stock to drill more than one hole in a piece. Cast-iron knobs may also be machined economically by following the preceding methods and considerable expense saved, especially when they are required to be finished on both ends, as was necessary on the one shown in Fig. 5. In this case both ends are finished by the cut-off tool *A* and the cross-slide drilling attachment is made use of.

The piece shown in Fig. 6 differs from those previously described in that the hole is cored. The piece is made from soft cast brass and is not required to be finished accurately. The method for drilling the hole is the same as described in connection with Fig. 4. When parts are made with cored holes the bars should be cast in much shorter lengths. Another example of work with a cored hole is shown in Fig. 7 where *A* is the cut-off tool and *B* the forming tool. The groove at *C* is molded into the piece to prevent a sharp corner when it is separated from the bar. Fig. 8 is intended to show how pieces which do not have a cylindrical shape may be cast into a bar and machined in the automatic screw machine. The piece shown is similar in shape to a wing nut and is cast in two separate parts, which are arranged cross-wise.

A study of the preceding cases will show that the largest saving is made when the work requires special operations which the hand turret lathe is not provided for, and also in finishing the work in one setting of the machine instead of chucking twice. Parts which might require special and expensive chucks on the hand machine are peculiarly adapted to be machined from the cast metal bar in the automatic screw machine.

In considering the molding of string patterns, three questions will naturally arise. 1. Can string patterns be readily molded? 2. Is the molding done by machine or by hand? 3. What is the relative cost of castings made singly and in strings, including the patternmaking? String castings may be molded as readily as single ones or those of the gang type, excepting those parts having cored holes which would be more difficult to mold in strings, owing to the length of the cores. For this reason the various operations on the latter (also on parts more than 2 inches in length) should be carefully estimated and compared with the added cost of molding, and they should only be machined in the manner described when the reduced cost of these operations justifies the more difficult method of molding.

Whether the piece is to be molded by machine or by hand depends upon four conditions. 1. The material: Parts molded of brass require more even ramming than when made of cast iron or steel and for this reason could be more readily molded by hand. 2. The length of the piece: The parts shown in Figs. 1 and 6 are of such length that in order to carry a sufficient quantity in one bar, the string pattern would be so long that it could be much more readily molded by hand than by machine. 3. The amount of accuracy required: In molding bars of this kind care should be taken by the molder not to rap the pattern harder at one time than another, and never to rap the pattern harder than necessary to remove it from the sand, as the first error would cause variation in the size of the work and the second cause the work to cast large. This would occur to a greater extent with hand molded bars than with the machine molded ones. But the same may be said of any castings and should not be held as an objection to performing automatic operations in the manner described, as this class of work is usually done on Cleveland automatic machines or those of similar construction which allow for adjustment of all cam or tool travel. 4. The quantity to be made: As in operations of every kind the quantity of parts to be made must be sufficient to justify the first tool cost. For example, the piece shown in Fig. 2 was made in a large molding machine carrying five bars to one mold. The cost of fitting the machine with patterns is greatly outweighed by the increased production, as but two bars could be made in a mold by hand, at one time; also about thirty or thirty-five bars could be machine-molded in the time required to mold two or four by hand. At the same time, it should be remembered that the machine would require two operators and the hand molding but one.

A comparison of patterns is shown in Fig. 9. A gang pattern for molding the piece by hand is shown at *A*, and *B* shows the methods of mounting the two halves of the pattern on a board for molding in a machine of the small type. This comparison shows that the expense of the string pattern and of the gang pattern would be about the same. The patterns for making the pieces shown in Figs. 1, 4 and 6 would be made in two halves, split through the center, having two bars in each mold (for hand molding). The length of the string pattern for the piece shown in Fig. 6 is 3 feet; this is shorter than the others on account of the core. The length of the string pattern for the pieces shown in Figs. 1 and 4 is 4½ feet. The pattern for the piece shown in Fig. 6 should have core prints extending about 1½ inch at each end to insure having the correct core location and to support the core which is made of dry sand. The patterns for the pieces shown in Figs. 2 and 5 would be made of metal, and for machine molding would be fastened to the plate on the machine. If the machine had but one plate only half patterns would be required, as the top and bottom of the mold could be made from the same half pattern. The piece shown in Fig. 3, however, would require two halves to the pattern on account of the cam-lugs which it carries. The piece shown in Fig. 7 may be machine-molded, one mold carrying five or six bars, and the length of each bar should be about 3 feet. A machine-molder could make about seventy-five molds a day (of parts similar to those described) which would equal several hundred pieces, according to their size and the number cast in one mold. A safe estimate on the same work performed by hand would be about one-fifth this amount, making allowance for two men operating the molding machine. In conclusion, the writer wishes to state that the crop ends of the bars were allowed to accumulate until there were enough on hand to machine in the hand screw machines. In some cases this proved advantageous in making the special parts which are often required. These parts differ very little from the regular work and are usually ordered in very small quantities.

BOLT AND NUT MAKING*

GENERAL METHODS USED IN FORGING AND MACHINING BOLTS AND NUTS

BY DOUGLAS T. HAMILTON†

WHILE the articles on bolt and nut making which appeared in previous numbers of MACHINERY contained considerable information on this subject, there were some details that were not fully dealt with. In the following article, a general resumé will be given of the methods used in a large bolt and nut factory in the Middle West that makes bolts and nuts exclusively. It is therefore evident that the processes used here are, to a certain extent, characteristic of those in general use in the industry.

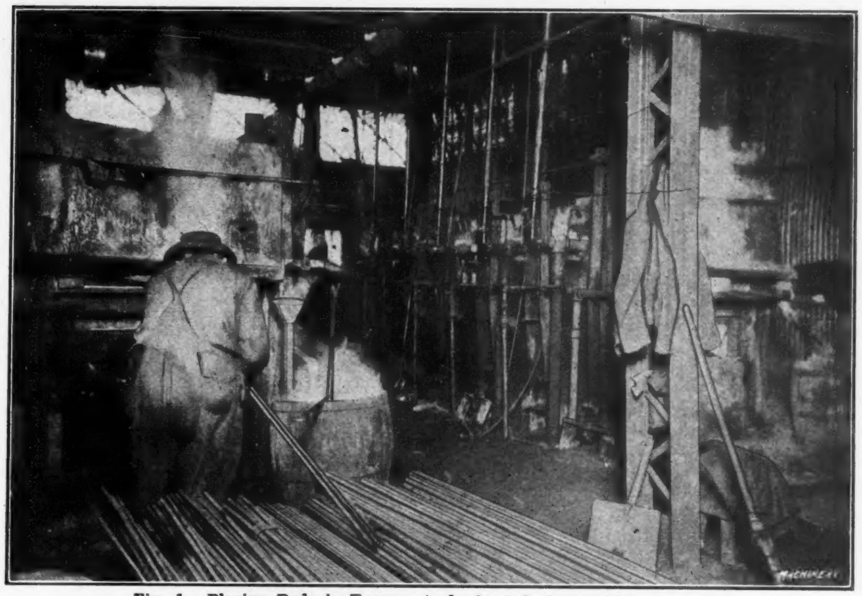


Fig. 1. Placing Rods in Furnace to be heated, from which they pass to Acme Continuous-motion Bolt-making Machine

Heading Bolts

As an example of bolt heading, threading, etc., a 5/8-inch machine bolt 2 inches under the head will be considered. This is made from Bessemer steel rod that is obtained in bars 14 feet long. As shown in Fig. 1, the bars of steel are arranged in a pile at the rear of the furnace and are inserted in the manner illustrated. The furnace is 15 feet long and is heated by natural gas. The temperature to which the rods are heated varies from 2100 to 2200 degrees F. When they have attained the proper temperature the forging machine operator grips one of the bars with a pair of tongs and inserts it in the feeding rolls *A* of the Acme continuous-motion bolt and rivet machine shown in Fig. 3. These rolls are located about 1½ or 2 feet from the front end of the furnace and as the bar is not very large in diameter and cools quickly, it is protected by sheet steel guards in its passage from the furnace to the rolls to keep the temperature as uniform as possible. From the rolls, the rod passes to the gripping dies, where it is gripped, headed and cut off. The machine used for making this bolt is called a "continuous motion bolt and rivet making machine," because the operation is continuous, the bolt receiving only one blow and then being cut off; this sequence is continued uninterruptedly until the bar is completely used up. The production from a machine of the continuous-motion type is evidently greatly in excess of that which can be obtained from single-blow machines. The continuous-motion machine produces from 25,000 to 30,000 bolts in ten hours.

A rather ingenious arrangement is used in connection with the Acme forging machine for carrying the bolts away from the machine. It consists of a short escalator operated by the belt *B* and pulley *C*. The bolts, after being headed and cut off, drop from a chute in the forging machine onto this traveling platform and are carried up by it and dumped into a sheet-iron wheelbarrow, as shown in Fig. 2. When this becomes filled, it is removed and an empty one put in its place. It is therefore unnecessary to pick the bolts up off the floor. This is a very convenient method of transporting them for the other operations. Fig. 2 also shows the position of the operator when he feeds the heated rod into the feeding rolls of the machine.

Removing the Flash

Following the forging operation, after the bolts have become cold, they are transferred to another machine where the flash is removed. The bolts are put in a chute attached to this machine and pass down to a slide from which they are carried into the shearing dies by means of a segment carrier. When this carrier makes one-quarter turn, another slide, operated by a bellcrank and traveling in a position at right angles to the first carrier, picks up the bolt and carries it to the dies. The dies are in segment form and are operated from each side by cranks that receive movement from a slide through the action of a cam groove. Two spring rods fitting in a longitudinal groove act as ejectors for the bolts. The trimming is accomplished by a punch in connection with the dies, which forces the bolts right through the dies into a box under the machine, removing the flash that has been produced by the forging machine dies. This trimming operation is necessary because it is practically impossible to produce bolts in a single-blow continuous-motion bolt and rivet machine without producing flash, especially if a good full head is desired.

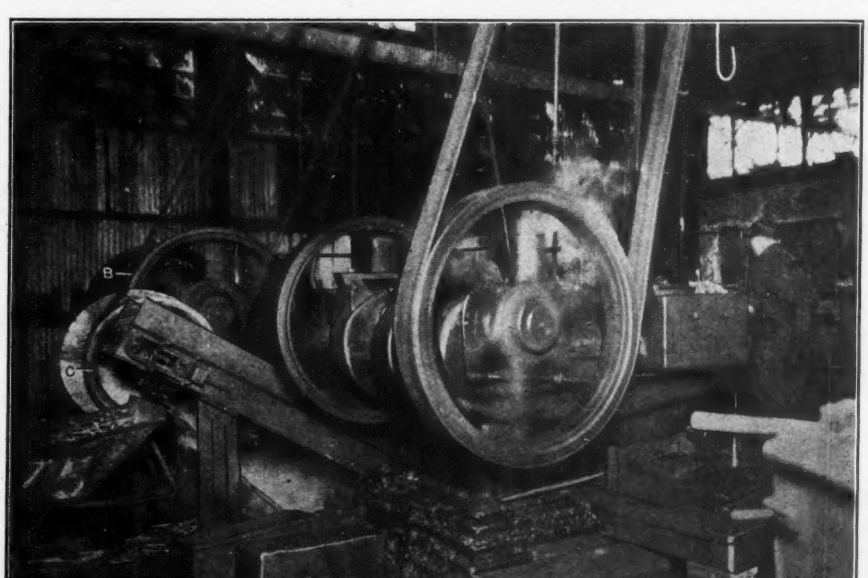


Fig. 2. Rear View of a Pair of Acme Forging Machines, built by the Acme Machinery Co., Cleveland, Ohio, showing Methods of conveying Bolts from Machine to Wheelbarrow

Pointing or Chamfering Bolts

In order to facilitate the starting of the threading die on the body of the bolt and also to produce a good end, the bolts before threading are chamfered and rounded off at the same time. The cutting-off operation in the forging machine produces an end that is not altogether straight but is rounded on one side of the body and sharp on the other. This pointing opera-

* For information on bolt and nut making previously published in MACHINERY, see the series of articles on "Machine Forging," in the April, May, June and July, 1913, numbers.

† Associate Editor of MACHINERY.

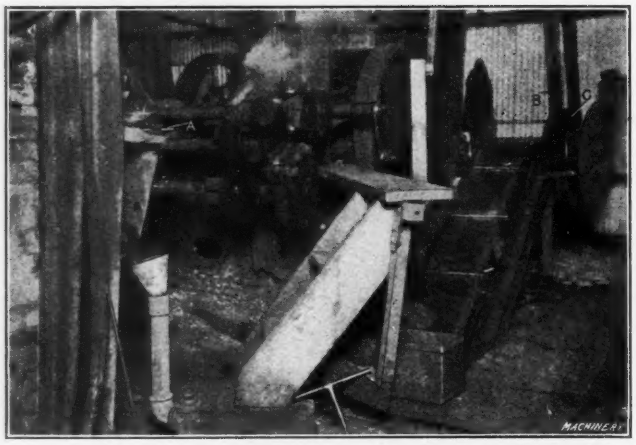


Fig. 3. Close View showing Rod coming from Furnace and being fed into Acme Bolt and Rivet Machine by Feeding Rolls

tion removes this defect and facilitates the starting of the dies. The pointing operation is accomplished in a machine of the type shown in Fig. 4. This is a small bench machine, operated by hand and foot power. The operator holds the bolt in a nest attached to the slide *A* which is forced forward by means of a bellcrank connected by a chain to the foot treadle *B*. The pointing knife is held in the head *C* and is formed on the inner end to the same shape as that required on the end of the bolt. This bench machine can be operated

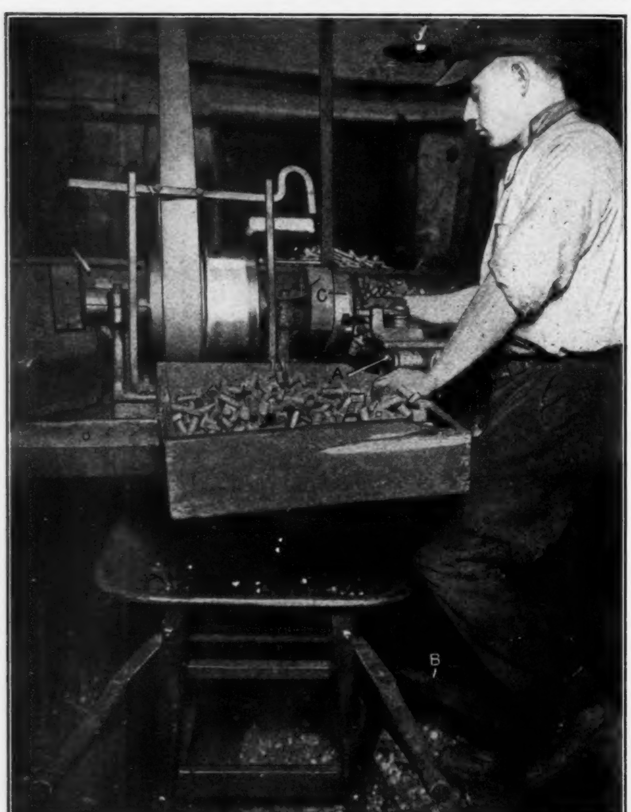


Fig. 4. Pointing Bolts prior to threading

very rapidly and one operator can turn out 25,000 bolts of the size previously mentioned in ten hours.

Threading Bolts

Following the pointing operation, the bolts are taken to the two-head threading machine shown in Fig. 5. This machine is provided with two slides, and while one bolt is being threaded the operator is inserting another in the other slide so that one slide is practically in continuous operation all the time. The thread produced on this bolt is 5/8 by 11 pitch, 1 1/4 inch long. The work is just slipped into a groove in a plate fastened to the slide and is backed up by a bracket provided with another plate which bears against the head. The slide is operated by hand to bring the bolt into contact with the chasers of the threading die and then the bolt automatically leads into the die itself, by the action, of course, of the pitch of the chasers. On this machine 6000 bolts can be threaded in ten hours. This finishes the machining operations on the bolt.

Hot-forged Nut Making

The nut used in connection with the bolt just described is of square section and is produced in the hot-forged nut machine shown in Fig. 8. This type of machine, as was described in a previous article, is only used for making square nuts but produces these without fins or burrs. The bar used for making the nuts is 15/16 inch by 19/32 inch thick by 10 feet long and the nut produced is 1 inch across the flats and 9/16 inch thick. The bar is heated in the furnace shown to the right to a temperature varying between 2100 and 2200 degrees F., for a length of about 3 1/2 feet—three heats finishing a ten-foot bar. The bar is then removed to the forging machine and is turned over after making each nut. The method of making square nuts in a machine of this type was clearly illustrated in a diagrammatical view, Fig. 42, that appeared in connection with the article on this subject in the June, 1913,

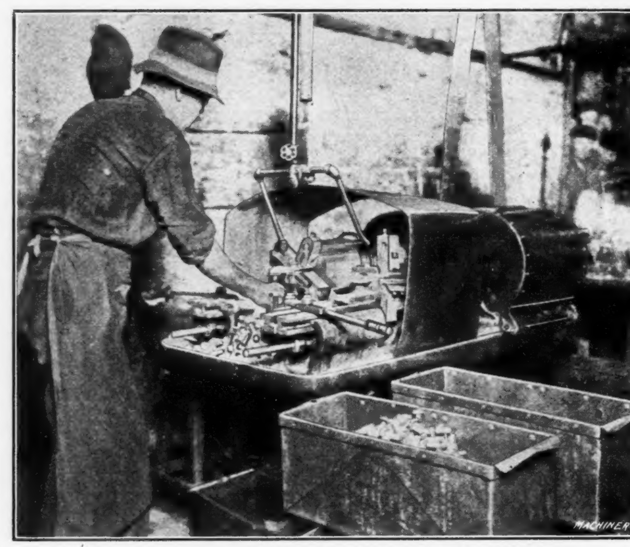


Fig. 5. Threading Bolts in Two-head Threading Machine

number of MACHINERY. The production of 5/8-inch nuts from a machine of the hot-forged type varies from 2800 to 3000 pounds in ten hours, or in other words from 24,800 to 26,600 nuts.

Tapping the Nuts

The tapping of the 5/8-inch nuts is accomplished in six-spindle Acme semi-automatic nut tapping machines, a row of which is shown in Fig. 6. Fig. 7 shows a closer view of one of these machines and illustrates the operation of the feeding mechanism and tap. Referring to the latter illustration, it will be seen that the nuts are fed down to the tap through the slide *A* and are moved over in line with the taps by the feeding finger *B*. This feeding finger is operated from a rod at the rear of the machine through a system of levers which come into action as the spindle of the machine is lifted.

Each tap-holding spindle is operated independently. It is counterweighted to prevent breaking the taps and is provided with an automatic lifting device consisting of a worm and auxiliary mechanism. By means of this device, the tap is lifted after one nut has been tapped, allowing the next nut

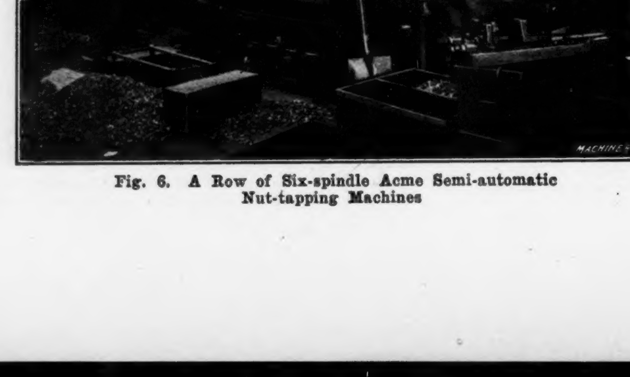


Fig. 6. A Row of Six-spindle Acme Semi-automatic Nut-tapping Machines

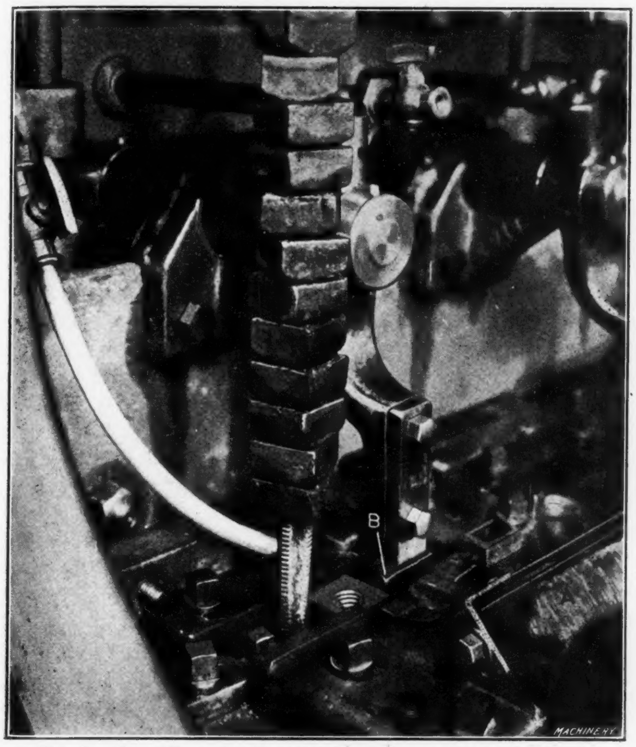


Fig. 7. Close View showing Operation of an Acme Semi-automatic Nut-tapping Machine

to be fed in automatically from the chute to the nut holder. As the tap passes through the nut, the worm shown at the top of the spindle in Fig. 6 drops, and in so doing, comes in contact with a bronze washer. This washer, through a bell-crank arrangement of levers, pushes a shoe into contact with the threads of the worm, whereupon the latter rises and lifts up the tap so that it clears the nut and nut holder, allowing another nut to be fed in. When the tap becomes filled with nuts, it is removed from the spindle by the operator. The spindle automatically stops when the tap is full, as the tap filled with nuts prevents the worm from contacting with the bronze washer. The tap is removed by depressing a foot lever and is held in place by quick-acting ring chucks. The production of ⅝-inch nuts from a six-spindle machine of this kind is great, varying from 15,000 to 17,000 per day of ten hours.

For nuts smaller than ½ inch, Acme semi-automatic nut tapping machines of the hopper type, as shown in Fig. 9, are used. The hoppers of these machines consist of a receptacle inside of which there is an arrangement similar to a turnstile. This agitates the nuts and feeds them down through a chute from which they pass to the chuck. This machine is provided with three spindles carrying taps, but only one tap is in operation at one time on a nut. As one tap becomes filled with nuts, the work-holding turret indexes and brings another tap into operation. This sequence of operations is continued until all the taps are filled. A bell then rings and the operator removes the taps, strips the nuts from them, inserts the taps again and starts the machine. Production on a machine of this type is high, ranging from 15,000 to 20,000 standard ⅜-inch nuts per day of ten hours.

Fig. 8. Making Square Nuts in a Hot-forged Nut Machine

THE LOCOMOTOR

An interesting engine for switching purposes has been developed in Germany during the last year or two. It is known as a locomotor, and consists of a small gasoline or oil engine placed on a wheel base running on the rails. This apparatus weighs about two tons and would therefore be too light to exert the tractive force necessary in switching any considerable number of cars. This difficulty, however, is overcome by an ingenious arrangement by means of which part of the weight of the car to which the locomotor is coupled is transferred from the wheels of the car to the wheels of the locomotor, so that the weight of the car being switched is added to the weight on the driving wheels of this novel switching engine. It has been found especially advantageous to use this motor at small and medium-sized stations, harbor tracks, etc., where the work to be done is hardly enough for a regular switching engine and where the cost of using such an engine is therefore excessive. It is stated that the same work can be performed for less than one-third the cost by using an arrangement such as described.

An interesting item in connection with the development of the locomotor is that its inventor is not a railroad man but an architect. This is another of many examples of how men trained to a certain line of work seldom conceive radically

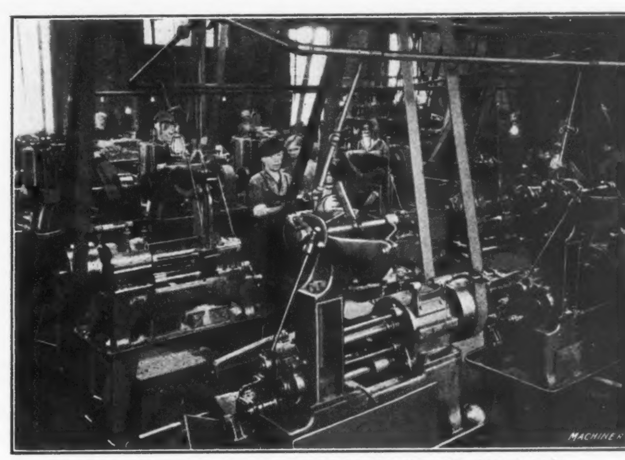


Fig. 9. Hopper Type of Acme Semi-automatic Nut-tapping Machine for Small Nuts

new ideas for doing that work, but rather develop along the lines into which they have been trained, whereas a man comparatively unfamiliar with the general practices in a trade or industry may sometimes conceive of improvements of great value which a specialist would never have thought of.

* * *

It is estimated that over 32,000,000 barrels of crude oil were used for fuel by railroads of the United States in 1912. This is an increase of over 4,000,000 barrels as compared with 1911. During the last few years crude oil has replaced coal on many of the railroads in Texas, Oklahoma and Louisiana. The adoption of oil for fuel has added greatly to the comfort of the traveling public and has lessened the labor of the firemen as well as reduced the cost of operation. Over 1200 oil-burning locomotives are in use on the Southern Pacific and more than 800 on the Santa Fe. The total mileage of railroads now operating with fuel oil is about 28,000 miles.

CONVEYORS AND CONVEYOR SYSTEMS

DIFFERENT TYPES OF CONVEYOR SYSTEMS—PRINCIPLES GOVERNING THE DESIGN OF CONVEYOR BELT PULLEYS

BY C. F. HERINGTON*

THE application of machinery for handling and conveying heavy and bulky material has of late assumed considerable importance. No branch of engineering has been more rapidly developed and less written about than the construction of appliances for loading and unloading heavy goods, particularly coal and ore. The modern flour mill may also be cited as an example of automatic handling. So perfect is its automatic equipment that wheat may be unloaded from an ocean-going vessel, stored, cleaned, graded, ground, dressed, packed, weighed, registered and delivered into a railroad car without any manual labor at all. The result is a saving in both time and labor, especially in the number of men employed, for with modern conveying systems the number of men is at least 25 per cent less than where manual labor is employed. Naturally there are heard objections to these labor saving devices, as being detrimental to the interest of labor; but experience has proved the contrary, for wherever we find these conveniences, we also find that the life of the laboring man has been made easier, higher wages have been paid and his economic value to the community has been greatly increased.

Although conveyor systems are, as a matter of history, only about twenty-five years old, so rapid has been their development, that there is now a conveyor system available for any and all kinds of material required to be handled. Conveyor systems are divided into approximately three different classes, each class having a number of styles and ways of performing the work. They are as follows: (a) bucket conveyors; (b) screw conveyors; (c) belt conveyors.

Bucket Conveyors

Bucket conveyors are usually designed for special purposes. For instance, grain conveyors are always encased in wooden and steel casings and the casings are nearly always vertical. The usual support for the buckets in this case is belting—either leather, cotton or rubber. For coal, coke and other heavy materials the buckets are fastened to chain links, either single or double strand, depending upon what capacity the conveyor is designed for; and in this case the conveyor casing is usually carried in a slanting position. Bucket conveyors should always be fed from the side on which the buckets ascend, so that the stream of material runs into the buckets, meeting them on their upward journey. This prevents the material from falling into the conveyor well and does not necessitate the buckets dredging through an accumulation of feed. With bucket conveyors of small capacity, however, it is customary to place a boot at the bottom of the well and the buckets pass down and through this boot and fill themselves coming up through the material.

The reason why bucket conveyors should sometimes be set vertical and sometimes in an inclined position is that in elevating materials of low specific gravity, a conveyor can be driven at a much higher speed than the conveyor which is handling material of higher specific gravity, as a velocity of the material at the point of delivery which would not injure grain, would break up coal and other heavier products. Moreover, the receiving spouts and chutes would be quickly destroyed by the impact of the material. Conveyors in a vertical position are, therefore, only suitable for specifically light material and can be run at a circumferential velocity of 250 to 350 feet per minute. Conveyors for heavy material must be wholly or partially inclined to give a clean delivery without scattering, and they should run at a speed of 50 to 160 feet per minute. It is for this reason that conveyors for specifically heavy material require so much larger buckets, chains, etc., than conveyors of the same bulk capacity for handling lighter material. Bucket conveyors should always be driven from the top so that the upward side of the conveyor (the side containing the load) can be tight, while the empty side will run slack. As a general rule, bucket conveyors are expensive to install and costly to operate, on account of their number of moving and consequently wearing parts, which are in constant need of renewal.

Screw Conveyors

The screw or worm conveyor is without a doubt one of the oldest types. The first screw conveyors were made of soft wood octagonal spindles into which were driven hard wooden blades with pegs at one end. In the course of time this was improved upon by cast iron sections being threaded on a square iron shaft, which was turned for suitable bearings at intervals of 6 or 10 feet. Modern screw conveyors are built up of sectional screw flights, that are fixed to a central shaft or spindle by means of its shank which is tapped and fitted with a nut. The spindle is usually made of steam pipe in lengths of about 8 feet, the different lengths being coupled together. Then there is the continuous screw conveyor, which is a spindle and screw all rolled in one continuous screw into sections of about 10 feet. Screw conveyors are fitted into a wooden or steel trough so as to leave a clearance of between 1/8 and 1/4 inch.

A detail of great importance in all screw conveyors is the intermediate bearing; this if cumbersome, obstructs the passage of the material—a drawback that must be carefully avoided. As all adjustable bearings are in halves and of necessity bulky, it is preferable to choose solid bearings, although they lack some advantages that the former possess. The best intermediate bearing is a small phosphor-bronze bushing, secured by a short piece of pipe to a cast-iron support. The pipe is screwed into the support and secured by means of a lock-nut. The bearing can be oiled through the pipe. A word of caution might be added here to the engineer about to install a screw conveyor system. Do not have too long a run for your conveyor without breaking in for a drive—say not over 200 feet for a 6-inch screw, and not over 300 feet for a 9-inch screw conveyor. If possible, always place your drive so as to pull the material toward the drive,

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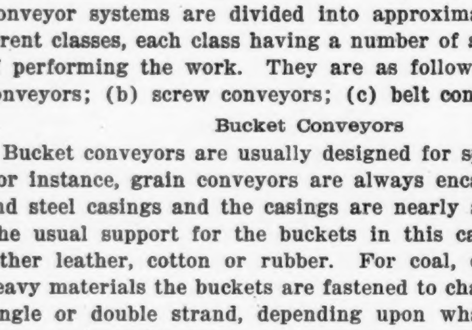

Fig. 1.

Fig. 1. Double Cone Belt Conveyor Pulleys—Objectionable owing to their Variable Surface Speed

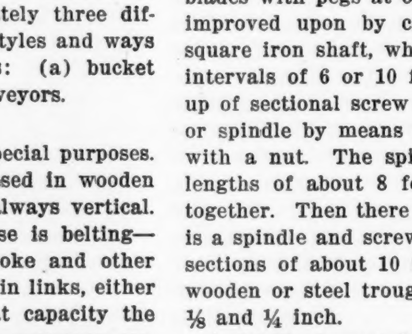

Fig. 2.

Fig. 2. "Dish Pan" Pulleys which have the Same Disadvantages as Double Cone Pulleys

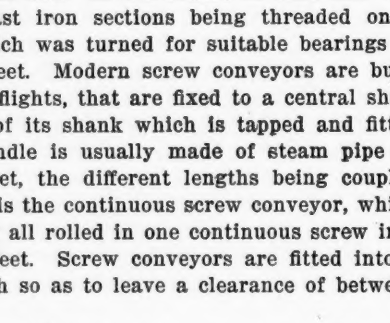

Fig. 3. Machinery

Fig. 3. Poor Types of Conveyor Belt Pulleys that cut the Belt instead of allowing it to be destroyed by Ordinary Wear

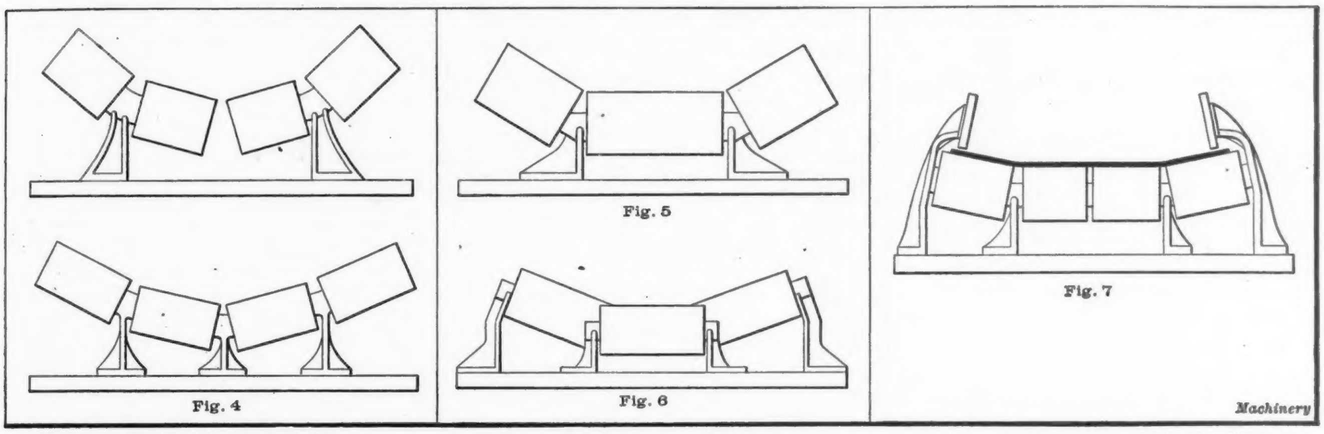

Fig. 4. A Better Type of Belt Pulley. Its Objectionable Feature is the Space at the Center

Fig. 5. Efficient Form of Belt Pulley with Central Space fully supported
Fig. 6. Best Type of Belt Conveyor Pulley

Fig. 7. Belt Conveyor provided with "Skirt Boards" to hold the Material in Place

never at the opposite end so as to push the material away from the drive. If one of the flights or a shaft bearing breaks, you can bring what material lies between the break and the drive toward the drive, while in the other case, if a break occurs you will continue to pile up material and trouble for yourself at the point of breakage, before your overload release coil on the drive will stop the screw.

Belt Conveyors

And now we come to the belt conveyors which, of all conveying systems, are the simplest and best. They are simple in construction, have a minimum number of wearing parts, are positive in action and can be used as carriers on both runs of the belt. Belt conveyors are independent of the carriers and can be loaded at any point, either by hand from bins or by means of automatic feeders; and they can also be discharged at any point and are reversible. They can be used for conveying material in sacks and packages as well as in the bulk, and can be built on portable frames and moved from place to place, all of which tends to make them an ideal system for conveying. From the start, however, the writer hastens to say that putting a belt over two pulleys, pulling and tightening until it is perfectly flat, and installing guide pulleys to "steer" it, does not by any means constitute the successful installation of a belt conveyor. On the contrary, there are a number of points, each small in itself, but which in the aggregate make or unmake a belt conveyor. Some of these points I will try to explain.

Troughing Idlers

The troughing idlers are often constructed more for the immediate convenience of their individual manipulation than with thoughtful consideration for the wear and tear of the belt. As this is first, last and always an item of the greatest importance, it ought to be considered first. Pulleys in line may have a tendency to act like a pair of shears and this is continuous and intensified when the loads are heavier than they ought to be, or when the carriers are spaced too wide apart, a condition that is a fruitful source of destruction to the belt. As a rule, in a belt conveyor of any appreciable length, the belt represents at least two-thirds of the initial cost of installation, and it would hardly seem the part of wisdom to endanger the two-thirds which is subject to constant wear to effect a saving in the one-third which, owing to the nature of the material and the character of the work that it performs when under proper care and management, should last almost indefinitely. Such, however, is often the case. In all kinds of mechanical devices the construction and adaptability of the article in question is always the prime consideration in making a choice, and this principle holds good in conveyor belts, or should do more so than in most cases, because of their large initial cost and liability to injury through misuse.

When troughing idlers were first built they were designed for an angle of troughing of 45, 30, 25, and 20 degrees, and finally the five-pulley idler in contradistinction to the three-pulley idler, was made with the differentiation in the pulleys of 15 degrees. The reason for this is self-evident. The latter type more nearly conforms to the circular, eliminating angular bending and being a compromise, although a bad one because not necessary. Fig. 1 shows what was probably the first troughing idler, the double cone pulley. This design was objectionable because the diameter at *A* is much greater than the diameter at *B*, and consequently the surface speed of the pulley is greater at *A* than at *B*. This produces an abrasive action due to belt slippage, which rapidly divests the belt of the skin or covering, allowing it to absorb moisture and grit so that it is soon destroyed.

Fig. 2 shows the dish pan idlers. Here the three pulleys revolve independently of each other, the theory being that the belt would have a line contact only, as shown at *C*; but in practice it is found that a loaded belt takes the position shown at *D* and all the disadvantages of the double cone pulley still remain. Fig. 3 shows the worst type of troughing idler. Why? Because there is no support for the belt at the center where the load is carried. There is a rolling shear action that cuts the belt, and it sags between the carriers under the weight of the load. The result is that the belt is cut in halves and destroyed, not worn out. Fig. 4 shows the four-pulley type of troughing idler. This is a little better, but is still objectionable on account of the fact that it is open in the center.

Fig. 5 shows a good design of troughing idler, eliminating slip and scour, for the pulleys revolve independently, but not in the same place. Fig. 6 represents the latest and the most perfect of the three pulley designs. It eliminates the rolling shear effect of pulleys in line, while retaining all the other advantages of the general idea. This type of idlers, with the end pulleys at an angle of 40 degrees from the horizontal, used in connection with a good rubber belt, gives the maximum results and a perfect belt conveyor. Fig. 7 shows what is often found on belts that are so flat that the material will spill if not controlled. This is done by what are called skirt boards and they are "death" to a belt. The material catches or scrapes against the skirt board as it passes, digging into the board and into the belt as well. Material gets under the skirt boards and grinds its way along, cutting the edges off the belt and making it narrower and narrower, until entirely destroyed.

Abrasion of Belt

The abrasion of a belt is controlled by so many factors that we will necessarily have to take them up individually.

First: A conveyor belt should never be called upon to do any other work than transfer the material from point to point. But often it is called upon to stop the velocity of the material, producing abrasion that is illegitimate and ought to be taken care of in the design of the transfer or feeding chutes, but which unfortunately is not the case. There are two methods of making transfers: one using gravity, which is always preferable when conditions make it possible, and the other, in cases of absolute necessity, utilizing velocity.

Second: Much depends upon the correct design of the transfer chutes. Too often we see skirt boards used, running parallel with the travel of the belt, to control the spill of the material due primarily to the inability of the belt to conform to the outline of the troughing idler, which in many cases is running almost flat, and in these cases the

material catching under the edge of the skirt boards has to drag and wear and abrade until it has reached the end of these retaining devices. This is wrong—absolutely wrong. If the transfer is properly designed, with the center sufficiently contracted and the noses or leads given the necessary freeing angle, skirt boards can be entirely eliminated, and the belt relieved of this wear and tear, which is unnecessary and very destructive.

Third: Installing elevating belts at too steep an angle or running them too fast produces slip and scour. There is a relation between the speed and angle of elevating which must not be overlooked. You can put a sheet of paper under a glass of water and draw it along or you can snap it out and not move the glass.

The Driver or Head Pulley

In order to conform to false economic ideas and to reduce first cost, the head or drawing pulley is often made too small, increasing the necessary tension in order to obtain traction, whereas the true common sense of conveyor belt driving is to have the traction without tension. In dynamo driving, as well as in conveyor driving, tension must be eliminated if you wish to get the best results in longevity of your belting. This is sometimes overcome, or attempted to be, by the use of lagged pulleys, but too frequently this is only the excuse for decreasing their diameter rather than decreasing the tension. In no part of the design of belt conveyors is more damage done than in this one particular feature, for it is true that the usual type of conveyor belt requires absolutely this excessive tension in order to make it track or approximately run true.

Cleaning a Conveyor Belt

The method that is commonly used of employing a brush to clean the conveyor belt and often using it on a tripper between the two pulleys to prevent the material on the working side being imbedded in the cover of the belt by the pressure of the snub pulley, is bad to say the least. Both the pulleys on a tripper are crown pulleys, which prevents the brush from having a level or flat surface to operate against. If the material is wet, as is often the case, it clings and cannot be removed except with the use of so much pressure by the brush on the belt as to do serious damage to the cover, as well as rapidly wearing the brush, necessitating an almost constant adjustment. A much preferable method of cleaning a belt is to have a driven shaft with loose auxiliary shafts pivoted together and thrown out by centrifugal force, which strike

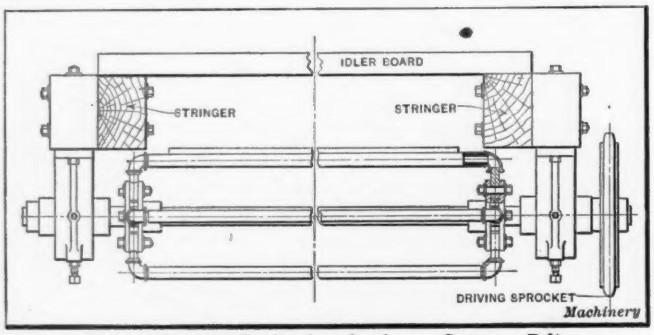

Fig. 8. Efficient Device for cleaning a Conveyor Belt

the belt with a continuous and incessant series of blows, jarring the material loose and necessitating no adjustment. This method is equally efficient and divested of all the disabilities inherent in the use of the complicated mechanism required to operate the brush. Such an equipment is shown in Fig. 8.

Improper Handling

In operating belt conveyors in series, especially if any of the sections are elevating, there should be a gradual stepping up of speed from the initial receiving conveyor to the ultimate distributing conveyor, if it is desired to prevent breakage. If the item of breakage does not enter into the problem, the speeds can be uniform. To produce breakage, choke a thin rapid stream with a thick, slow one by incorporating a large slow-moving conveyor into a series of conveyors with faster speeds, and this object will be accomplished. When starting, the conveyor should be at full speed before any material is fed onto the belt; and when stopping, the conveyor should be run at full speed at least five or ten minutes after the feed has been stopped, in order to have delivered the laggards or those pieces which may have a tendency to roll back, and which if delivered over the head pulleys when going slow, join in the transfer chutes and thereby do great injury to the belt.

Snub Pulleys

It is preferable, where it is possible to eliminate snub pulleys, to do so, rather increasing the diameter of the head or tail pulley and making a long lead to the first return idler; as the tendency of all snub pulleys is to bring the working surface of the belt with the material clinging to it against this snub pulley, embedding the material, which cuts its way into the body of the belt and thereby does serious damage.

Feeds

Correct feed is often the most essential adjunct of a belt conveyor, for its successful operation, and needs careful thought and consideration. The general principle involved is that the material should reach the belt moving in the same direction and at approximately the belt's speed or travel. This can be done in most cases, and always, if sufficient thought is given to the proposition in time. The feeding chute should be arranged to deliver the bulk of the load to the center of the belt, having the wings or leads sufficiently opened up or at an angle, so as to make the belt free itself and let the load distribute and come to a state of rest.

Deep Troughing

Originally belts were designed to have a deep trough. This gives the greatest capacity, cleanest carry, it is the easiest to feed on and to design the feeding chute for, and has only been modified to conform to the weakness developed in the belting which broke at the bending points, where the horizontal and angle pulleys met and sheared and destroyed the belt. To any longer suffer under the prejudice of this modified and unmechanical condition and construction is not necessary.

Decking

One of the most important features of a conveyor system, and the one too frequently overlooked, is the necessity for protecting the lower returning belt from any material dropping on it; and this is particularly true when the feed is very close to the end pulley, as is usually the case. This is very destructive, especially in carrying such material as ore, stone, gravel, coke, and in fact, almost any material, because it goes between the inner and unprotected surface of the belt and the pulley, and is embedded, destroying the thin film of protective cover, baring the fabric, allowing absorption of moisture and grit, and producing rapid destruction and disintegration of the belt.

Spacing of Idlers

When it is considered that the belt usually represents two-thirds of the cost of installation, the machinery one-third, and the troughing idlers often the least proportion of the one-third, it would seem the part of wisdom not to space them too far apart, producing an unnecessary sag in the belt and causing a flexing that does no good and often much harm. A little closer spacing is much to be desired and no additional power is required, as more power is saved by the elimination of the sag than is required to operate the additional pulleys. A perfect belt conveyor should embody maximum capacity, minimum expense, deep troughing and a clean carry, minimum tension and a perfect alignment, and absence of edge wear and corner break; all this can be obtained if you design the conveyor system to secure the desirable features mentioned and eliminate the objectionable ones.

* * *

Specifications for railway track scales adopted by railway engineers provide that knife-edge stresses shall not exceed 5000 pounds per lineal inch and that deflections in the levers from a straight line joining the end pivots should not exceed 1/2000 of their length, figured as a single beam. Unit stresses shall not exceed 2000 pounds for cast iron in tension, 3000 pounds for cast iron in compression, 7500 pounds for cast steel in tension and 8000 pounds for cast steel in compression.

WIRE PRODUCTS AND WIRE-WORKING MACHINES*

SOME OF THE PRACTICAL AND COMMERCIAL ASPECTS OF THE MANUFACTURE OF PARTS MADE FROM WIRE

BY E. R. MINER†

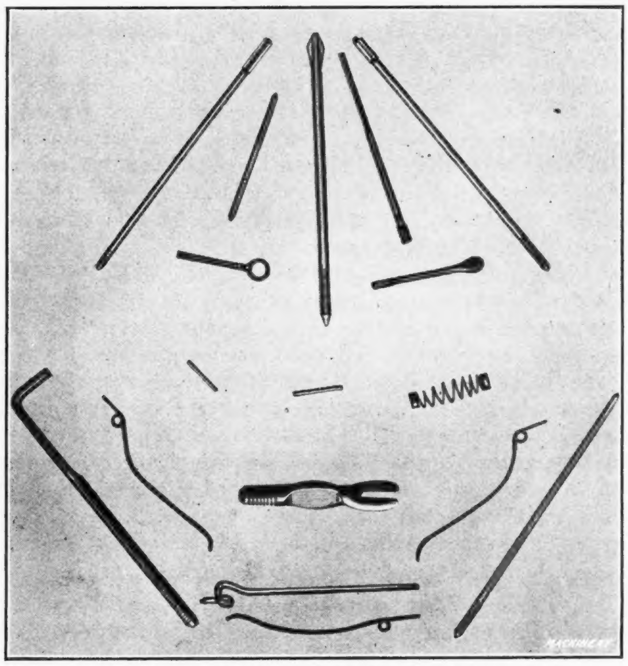

Fig. 1. Some Wire Products used in the Manufacture of Pianos

IN every piano there are from sixteen to twenty-four different parts made from wire, and of some of these parts, two hundred or more are used. In all the pianos annually manufactured, many millions of these wire parts are employed. Suppose a certain section of the country turns out 10,000 pianos a year. One particular wire product forms a part of each key action. On a piano there is an average of eight octaves or 104 keys. Then of this one product alone, the 10,000 pianos would use 1,040,000 pieces. Made by hand, this product would require much labor and mean considerable business and the cost would be heavy. These parts are not made by hand, however, but are turned out by automatic machinery at the rate of 150 a minute. One operator can easily run three machines so that the entire requirement of this particular piece for the 10,000 pianos could be supplied by the work of one man with proper machinery in somewhat less than four days of eight working hours each. As a consequence, these parts can be sold very cheaply and also as a consequence, the supplying of only 1,040,000 of these parts would not be much of a business.

As before mentioned, there are from sixteen to twenty-four other parts that are made from wire, and there are many more than 10,000 pianos made in a year. No one manufacturer of pianos, though, will use enough of any particular wire part to pay for an investment in the necessary machinery for making it. The piano manufacturer finds it cheaper to buy them, which fact creates a distinct business —that of piano hardware, and probably 90 per cent of all the piano hardware is manufactured by half a dozen concerns. Judged by the number of separate parts, the business is enormous, as 40,000,000 to 50,000,000 pieces of one kind is no unusual output for one manufacturer. Before the days of the automatic wire-working machine, filling such an order would have been a practical impossibility—it would have required all the resources of a dozen factories, but as business is today, an order for 50,000,000 parts is just a filler in—it represents one more product to help keep the automatic machines going.

What is true of pianos is true of pretty nearly every industry. The electrical trade uses thousands of differently formed wires as do the shoe, clothing, cleaning, dyeing, laundry, harness, automobile trades, and in fact practically every trade uses wire in some form or other. The butcher uses a galvanized wire skewer in the roast beef instead of the old-time wooden pin. Even the humble clothespin creates a market for some millions of wire springs a year.

The General Conditions of Wire Forming

A wire shape used on a piece of electrical apparatus might require the utmost exactness as to accuracy, while a wire shape used on a toy might be satisfactory within a rather wide range of limits of shape, size or length. Perhaps the electrical part is not used in large quantities, and looked at from a quantity standpoint, it might appear that it could be made by hand. After an investigation, this would be found impossible, because on account of the extreme accuracy required hand labor would increase the cost so much that it could not compete with something else on the market. The part could be made complete in an automatic wire-forming machine, but the quantity required would not warrant the investment necessary unless the same machine could be used for other purposes. The solution of the problem would be in having the parts made outside by some factory already equipped with wire-working machinery, or if for some reason this is undesirable, in making tools which can be used in a press or other machine. But this method would require perhaps several separate handlings and operations.

In the case of the toy part, cheapness and quantity required would forbid any method of manufacture other than by automatic machinery. Suppose, for illustration, a piece of wire is to be bent into the form of a staple. If the wire were light and easily bent, and only a few pieces were required, the operator would grasp the two ends, after it was straightened and cut off, and bend it over a piece of round rod or pipe. If the wire were hard and of large diameter, he would use a hammer or pair of pliers. In either event, he would likely get one leg of the staple longer than the other. Of course the two legs could be made to the same length by working more carefully, measuring to the center and working over a form, but the time consumed would be greater. If he had a bench or hand-manipulated bending machine, the stop would be set at a correct distance and the forming tools

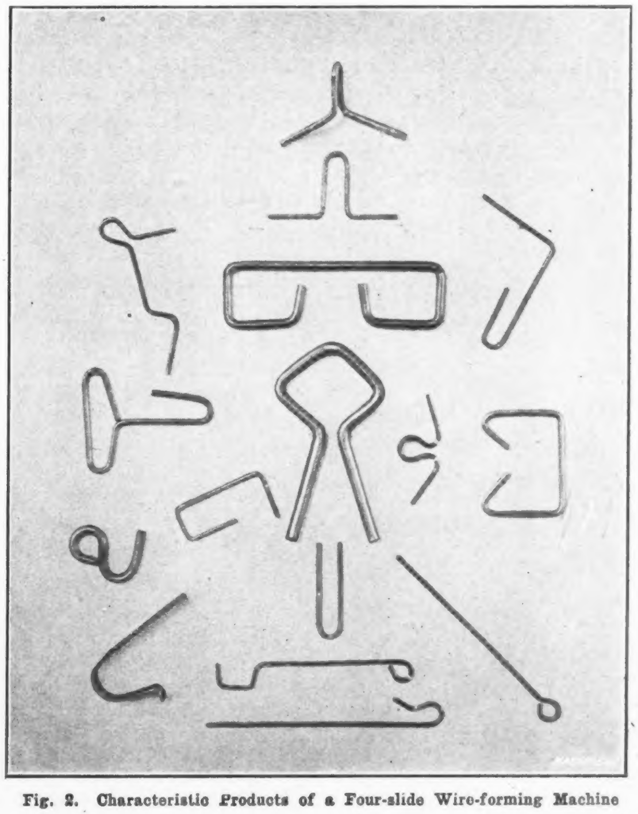

Fig. 2. Characteristic Products of a Four-slide Wire-forming Machine

* For other articles on wire-forming machines and tools see "Tools for Four Slide Automatic Wire-forming Machines," published in the February, 1912, number.

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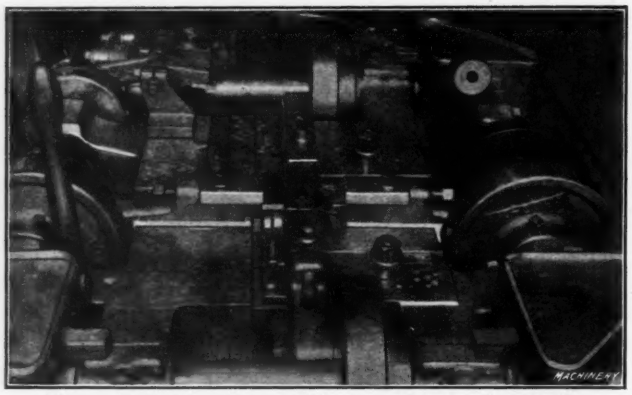


Fig. 3. Flat Bed and Four Slides of a Wire-forming Machine

or pins properly arranged, and then by bringing the wire up to the stop and pulling the handle, the staple would be bent properly, provided the wire was held firmly to the stop. If the wire was allowed to slip, the two legs would be uneven. If accuracy was required and the quantity was too great for such hand manipulation, the wire could be run through a wire straightening and cutting-off machine and then tools might be made which would permit of forming the wire in a press, but unless the wire form was very simple, the presswork would require several operations, using as many different sets of tools.

Each one of these methods might, under certain conditions, be satisfactory. It would all depend upon the quantity desired and the cost that could be afforded. Each method mentioned would vary the cost, as each method would give a different quantity output as a day's work.

Suppose that a shop has put out an article requiring in some part of its make-up a formed wire. The first orders were small and the wire pieces were formed by hand. As orders increased, the methods changed from purely hand work to the partly mechanical work of the hand-bending machine. At last orders reached a point where 5000 a day, or at the rate of 300 working days 1,500,000 a year were used. This was pretty large and they began to look around for improved machinery.

Now an automatic wire-bending machine might turn out this particular wire form at the rate of 200 per minute, or an entire day's requirement of 5000 in less than half an hour. For the balance of the day, the machine would lie idle. As the cost of such machine might be quite an item, the output would not warrant the investment. To get down to fundamentals we have:

1. In the manufacture of wire products the wire is usually purchased in the form of a coil. This wire has to be straightened and cut to length. This necessitates two operations, though if a straightening and cut-off machine is used it represents but one handling. After this, the wire may be formed:

2. By hand bending.

3. By bench or hand manipulated bending machine.

4. By special tools in presses in one or several handlings and operations.

5. By specially arranged or semi-automatic machines.

6. By full automatic wire-forming machines. (These last would take the wire direct from the coil and straighten and cut off.)

To decide upon the method to employ for any particular product one must consider: (A) Quantity of output desired; (B) accuracy required; (C) maximum cost that can be allowed; and (D) possible use of machines for other purposes.

These points are brought out because almost all wire-working machinery is purchased to meet certain requirements. If a manufacturer needs a lathe or a drill the purchase is a simple transaction. Either machine will accommodate different but standard tools, and will do certain kinds of work up to a specified capacity. The wire-working machine is a different proposition. If one is making a small, simple wire corkscrew that is given away with bottles of medicine, the quantity needed may be so large that it would pay to purchase a special machine fitted up to make nothing but these corkscrews. If the corkscrew was of more fancy design and the quantity required not so large, it might be advisable to purchase a standard wire-forming machine which by a change of tools, could be used for other purposes.

The point to note is this: the special machine may cost from $500 to $5000 more than a standard machine. Both machines make the corkscrew equally well, but the standard machine may turn out only fifty a minute while the special machine makes two hundred a minute, both working entirely automatically. Figuring on still smaller quantities, another type of machine might be bought for less than the standard machine, but such machine would be only partly automatic. That is, if the complete corkscrew required five operations, they might be split up and a machine built to perform three operations; then, by changing the tools and running through the machine again, the other two operations would be performed. Conditions might make any one of these machines the most economical to install.

It can be seen that while the specification 24-inch lathe may be a fair description of requirements, a request for a corkscrew-making wire machine would be no description at all. To obtain any basis of real cost, the purchaser must settle the questions A, B, C and D for himself, then make up an exact sample of the product and send this sample to the wire machine manufacturer, at the same time telling him the quantity required in a given time and the limits of accuracy. This last is important for the difference between a half-inch round bend and a half-inch square angle might mean a difference of several hundred dollars in the cost of the machine.

Typical Wire-forming Machine Principles

An automatic wire-forming machine is usually called a "four-slide." Stripped of technicalities, a four-slide machine consists of a flat bed of metal, over which operate four horizontal slides or plungers to and from a central former and at right angles to each other. Special tools are secured to the ends of these horizontal slides, and correctly timed cams move them forward so that the tools act on the metal progressively and in connection with stationary tools or formers fastened to the bed-plate or with tools which may be operated with the bed or in other ways.

The four-slide machine is really a series of small presses which are brought to bear upon different sides of the work in horizontal planes instead of working in a vertical direction as in common presses. In more complicated work, other little presses are added in the form of attachments which

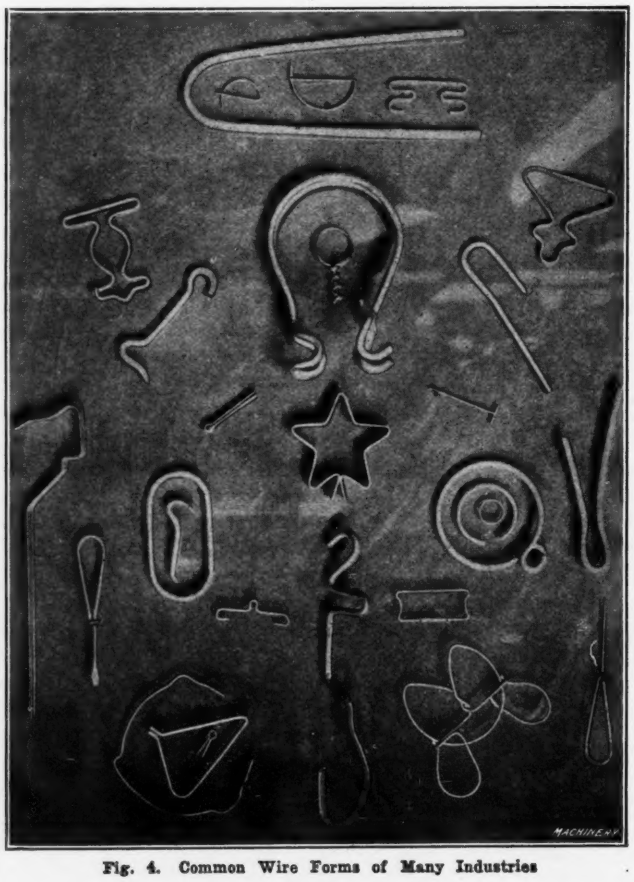


Fig. 4. Common Wire Forms of Many Industries

may be operated in a vertical plane or at various angles. If it was necessary to bend the wire into some simple form such as a right angle, tools could be made for an ordinary press which would satisfactorily form the wire into proper shape if the wire was fed to a stop and would at the same time cut it off. If, however, it was desired to form the wire into a rather complicated design, an ordinary press could not be used for a very simple reason. When the plunger of the press descends, it would necessarily operate on the whole length of wire within the press at practically the same time. If then there is a twist or bend in the center of the wire, there would not be sufficient opportunity for the wire to draw in from the ends to give the length required to make the center bend. In other words, the two ends of the wire would be gripped at practically the same moment as the center and there would be no forming length left.

But on the automatic wire-forming machine, or "four-slide," the cams are so timed that a proper length of wire will be straightened, fed into the machine, cut off and then each press or slide made to operate a fraction of a second later or earlier than another. In this way, the wire will be pulled forward, properly formed, relieved or carried forward again so that another slide can further form it, and so on. Each release or each forward carrying of the wire is allowed sufficient length of wire for the operation.

Action in Forming a Shape

Suppose that the before-mentioned staple is to be made in a four-slide wire-forming machine. The wire would be drawn from the reel and carried through the straightener and forward until the required length was central with a forming pin or tool. The front slide would then push forward and grip the wire at this point, holding it firmly against the forming tool. At the moment the slide grips the wire, the cut-off would operate to sever the proper length. Two other slides would then move forward, one from each side to bend the wire to shape. If there were some further operation to be performed, the back slide would move forward and complete the job. In the case of the staple-shaped piece, the back slide might be disconnected and not used at all, but if the article being formed was a ring the back slide would close the ends and set them. Allowance would be made in the shaping tools to take care of the spring of the wire, and the resulting product would be a commercially perfect article turned out at the rate of perhaps two hundred a minute—all alike.

Flat Metal Forming Machines

There are two types of "four-slides" on the market. One of them is termed the "wire-forming machine" and the other the "flat metal-forming machine." The wire-forming machine with suitable tools and attachments can be made to form, flatten, point, cut, mill and otherwise put into commercial shape products made from round wire. It will also operate

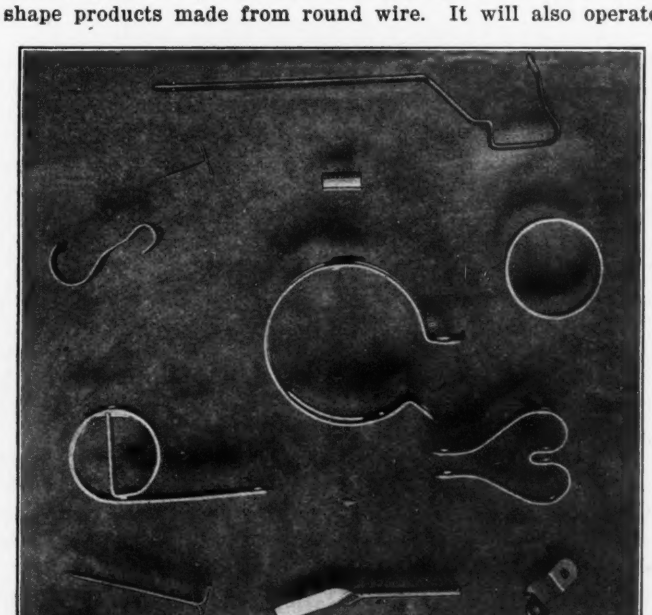


Fig. 5. Characteristic Products of a Four-slide Flat Metal-forming Machine

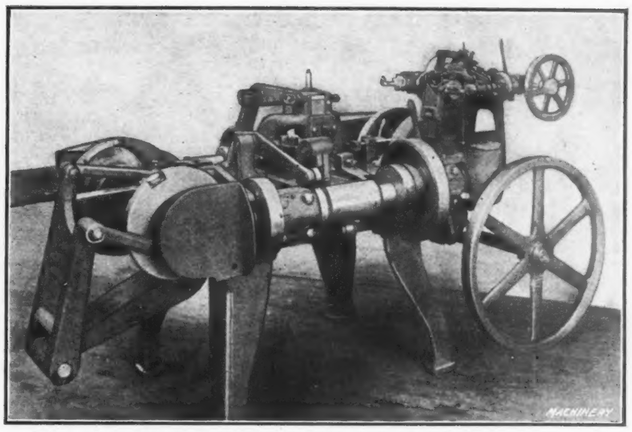


Fig. 6. Comparison of Sizes of Wire-forming Machines—a No. 00 standing on the Gear Guards of a No. 5

on flat wire or ribbon stock with the exception that it is not adapted to cutting specially shaped ends, piercing holes, or to light stamping or embossing.

The flat metal-forming machine is designed to handle ribbon stock; that is, narrow sheet metal marketed in coil form. This machine will do everything that a wire four-slide machine will do, and in addition it will cut specially shaped ends, pierce holes and do light embossing. Round wire can also be worked in this machine. In general appearance and mechanical principle, the two types of machines are alike.

Sizes and Capacities

Both types of four-slide machines are made in certain standard sizes, having a varying range both as to size of wire which can be handled and the length that can be fed into the machine. Sizes usually kept in stock for quick delivery run from the small No. 00 machine and include the Nos. 0, 1, 2, 3, 4 and 5 machines. The range of these machines covers the smallest worked wire up to ½ inch diameter, and the feeding capacity as to length runs up to 20 inches. Larger machines are built to order with a capacity of ¾-inch diameter wire and 24-inch feed.

The flat metal machine is not ordinarily carried in stock in as many sizes, but the size numbers run the same as those of the wire-forming machine. The capacity as to thickness and width of flat metal is figured on the cross-section area. For example, if a machine of certain size will take metal 0.032 inch thick and ⅛ inch wide, it would also take metal ½ inch wide if it were but 0.008 inch thick. The cross-section area of the first-mentioned stock is $0.032 \times \frac{1}{8} = 0.004$ square inch; and of the second-mentioned stock, $0.008 \times \frac{1}{2} = 0.004$ square inch also. It will be seen that the capacity of these machines as to width and thickness is rather too complicated to be discussed in this article, and any matters of this sort should be referred to a manufacturer. The feeding lengths of the flat metal machines run the same as for the wire machines.

Straighteners

The various mechanical details of forming machines vary with the different manufacturers, but the general principle of design is the same throughout and, as stated before, the general design of a flat metal machine is the same as the wire-forming machine. The wire, of course, is received in a coil, which is placed on a reel and thence goes to the straightener. Two types of straighteners are used, the double roll and the rotary. The double roll type is made in two forms—with rolls grooved to fit round wire and with wider plain rolls adapted to flat wire or ribbon stock. The double-roll and the rotary type of straightener are each adapted to its particular work and either may be applied, according to the characteristics of the article to be made or the quality of wire to be used.

The double-roll straightener is the one generally used and it is found satisfactory for the usual run of work. When used for round wire, one set of rolls is arranged horizontally and another set vertically, the rolls being grooved. For ribbon stock the rolls are plain and arranged vertically only. The rolls are staggered and adjustment is provided for bringing them closer together or setting further apart to accommo-

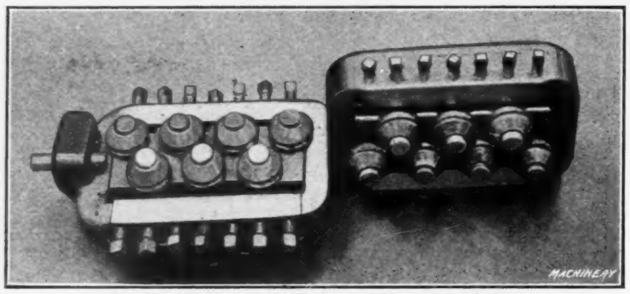


Fig. 7. Double Roll Type of Wire Straightener

date various thicknesses of stock. The action is very much the same as when drawing a piece of wire through the fingers. The wire is bent slightly in one direction and immediately after is bent in exactly the opposite direction. If released, the wire would take an intermediate position about half way between the two bends. The adjustment of the rolls is such that this bending back and forth takes out all bends and kinks and the wire leaves the straightener commercially straight.

A commercially straight wire appears absolutely straight to the average eye and this is all that is required for most articles. There are articles, however, in which greater refinement is necessary as to straightness, and the double roll straightener is displaced by the rotary type. The double roll type also is not adapted to the straightening of hard spring wire.

The rotary straightener has a steel spindle containing staggered steel guides. The wire is brought through a quill in the end of the spindle, and it then passes over the steel guides and out through the opposite end. The spindle is made to revolve rapidly and at the same time is reciprocated backward and forward, being mounted in a bracket on a slide and moving with the feed mechanism of the machine. With this type of straightener, wire can be made as nearly straight as it is possible to get it. For products such as typewriter bars, where perfect alignment must be had, the rotary straightener must be used to obtain satisfactory results. It is also used for working hard spring wire.

Feed Mechanism and Cut-off

Next to the straightener comes the feed mechanism. This is one of the most important parts of the machine. Unless the feed works perfectly, every subsequent operation will be thrown out of time. The tools will be jammed with an over length of wire or damaged by not receiving enough. This particular machine part varies considerably in design with different manufacturers. Essentially, it is an arrangement that slides along the wire a predetermined distance, closes on or grips the wire, and in returning, pulls a specified length through the straightener and pushes it into the machine to be operated upon. It is easy to understand that the gripping part of the feed is of chief importance. A good grip must take hold immediately so that each length of wire will be exactly alike. For the same reason, there must be no slipping through the grip, and, last, the grip must not mar, cut, flatten or otherwise distort the wire.

As the feed lets the wire go and starts on its return movement the wire, if not held, would tend to slacken or even

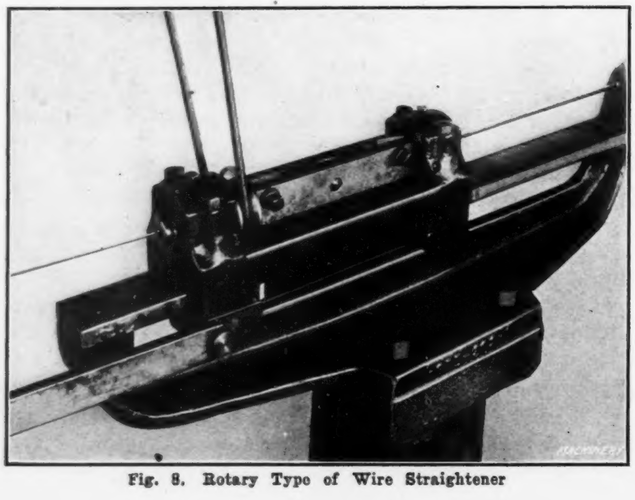


Fig. 8. Rotary Type of Wire Straightener

buckle between the feed and the straightener. To overcome this a second grip or binder is placed between the cut-off and the end of the feed stroke. As the feed grip loosens, the binder holds the wire tightly between itself and the straightener, preventing any slip and insuring the greatest possible accuracy in length of wire feed and cut-off. Next to the binder is the cut-off, and as its name implies it cuts off the wire in lengths predetermined by adjustment of the wire feed.

Form-holders, Forms and Stripper

Now we come to the form-holder bracket which holds the form-holder, which in turn holds the form. The form-holder bracket is adjustable to and from the wire line. When operating the machine this bracket has to resist all strain or push from the slides from four different directions. It must therefore be designed to resist all strain with a minimum of spring, and it should not in any way obstruct a full view of the tools while operating.

In most bending operations there is a principal die or forming tool around which the wire or metal is shaped. The form-holder is the machine part for holding this principal forming die, and there are three types as follows: the stationary holder, the swinging holder and the solid holder. The stationary holder is a type used for the lighter classes of product, being easily handled and containing only the necessary amount of metal. The swinging form-holder swings upon a pivot but is held to the wire line by a spring. In making narrow forms, the tool on the front slide presses the form-holder backward until it is solidly held against the

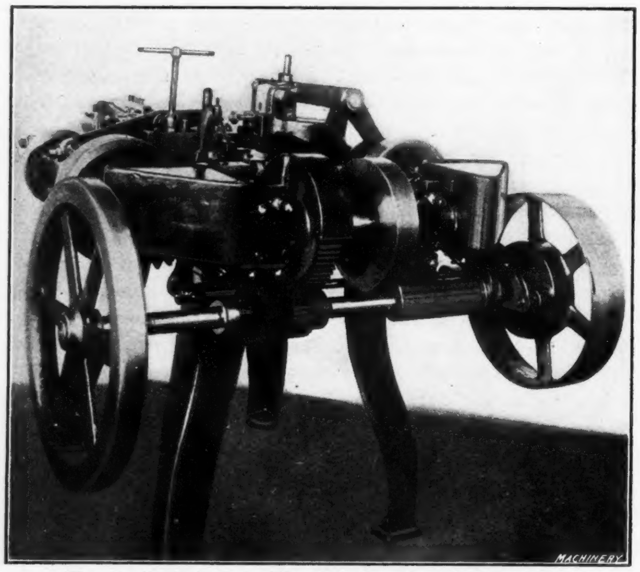


Fig. 9. Typical Four-slide Wire-forming Machine shown from another Angle than in Fig. 6

bracket, and this backward movement of the form allows room for the side tool to operate. Without such backward movement, the action of the side tool would be restricted, owing to the projecting bracket of the cut-off. The solid form-holder is similar to the stationary type but is of heavier construction and is usually built to fit solidly into the bracket, giving in effect a single mass construction. Regardless of the type, a tapped hole and grooves are provided on the lower end of the form-holder, to which the actual form or tool can be tongued and held securely in place.

We now come to the slides and lastly the stripper which is a rod passing down through the form-holder and having on its lower end thin stripper plates. The stripper rod is reciprocated by cams and the mechanism strips or knocks the work off the form to get it out of the way of the incoming wire.

These parts, briefly described, are the parts of a standard stock machine. Such a machine will form hundreds of different articles when provided with suitable tools, and by adding attachments these machines will turn out the most complicated kinds of work. As may be noted by referring to the illustration Fig. 9 the machine has four shafts running along the four sides. These shafts give ample space for the application of differently shaped cams, and being on all four sides, it is possible to obtain operation in any direction.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

What Machinery Must be Guarded

(Federal) Iowa statutes which makes it the duty of the owner of any manufacturing or other establishment where machinery is used, among other things, to properly guard "machinery of every description," as construed by the Supreme Court of the state, is intended to require the guarding of all machines of a character dangerous to employes operating them or working in their vicinity.—*United States Gypsum Co. v. Karnaca. 216 Fed. 857.*

Suit for Patent Infringement

(Federal) Where the owner of a threshing machine patent failed to mark all machines made thereunder with the patent mark, and, with knowledge of its infringement by another company, gave no notice of the fact for six years, which was the first that the other company knew of the existence of the patent, and afterward delayed bringing suit, it was held that the owner of the patent was not entitled to an accounting for damages or profits, but was not barred by such laches from enjoining the further infringement of the patent.—*Closz & Howard Mfg. Co. v. J. I. Case Threshing Mach. Co. 216 Fed. 937.*

Compensation of Machinery Salesman

(New York) Under a contract whereby plaintiff was employed by defendant, whose principal office was in New York City as an exclusive sales agent for machinery in certain territory, and was to forward all inquiries from outside his territory to defendant, who in turn was to forward to him all inquiries received by it from his territory, and whereby all sales by defendant for delivery and erection within his territory should entitle him to compensation, he was restricted to commissions upon machinery sold for erection within his territory, and a sale of machinery by defendant directly to a corporation having a main office in his territory but for erection outside such territory did not entitle him to a commission.

Under such contract, as modified by renewal provisions to the effect that the agent might sell machines to any purchaser whose main office was within his territory, but whose works were within the defendant's territory, and receive his profits thereon, and that when machines were sold by defendant to parties whose main offices were within defendant's territory, but were shipped into the agent's territory, the agent should be entitled to his share of the profits, he was entitled to a commission on a direct sale of machinery to a buyer whose main office was in his territory, for erection outside thereof, made directly by defendant by correspondence with the buyer's general office in the agent's territory, and also on a sale of which he was the procuring cause, made to a buyer with its main office in his territory, although the machinery was to be erected outside thereof, and on a sale to a buyer in his territory, though intended for outside territory, negotiated by him through defendant's office, but was not entitled to commissions on a sale by defendant negotiated through a buyer's branch office in his territory, the buyer's main office being in defendant's territory, or on a sale of machines to a company whose main office was outside his territory to be installed outside of such territory.—*McGann v. Ruggles-Coles Engineering Co., 149 N. Y. S. 696.*

Machinery Must be in Safe Condition

(Kentucky) A master must use ordinary care to provide his servants with machines reasonably safe, and the servants are not bound to inspect such machines to ascertain whether the master has performed his duty, but if a servant is injured by a defect so obvious that it would have been discovered by ordinary care he cannot recover.—*Fluhart Collieries Co. v. Meeks, 169 S. W. 686.*

Contract for Sale of Engine

(Kentucky) Where a contract for the sale of a traction engine provided that if within five days from first use it failed to fill the warranty, written notice should be given the seller and reasonable time allowed to remedy the difficulty, and if it could not be made to fill the warranty it should be immediately returned by the buyer to the place where it was received, with the seller's option to furnish another machine or return the money and credit the notes which had been received for the purchase price and thereby rescind the contract, it was held that the remedies specified in the contract constituted the only relief to which the buyer was entitled, and if he failed to return the machine and demand the purchase money and notes he was bound to pay the price.

Where the contract provided that no general or special agent or local dealer was authorized to make any change in the warranty, that workmen or experts had no authority to bind the seller by any contract or statement, or to waive any of the conditions of the contract, a local agent on ascertaining that the engine did not comply with the warranty had no authority to modify the same and direct the buyer to take the engine home or try to at the seller's risk or expense.—*Nichols & Shepard Co. v. Stubbs Thresher Co. 170 S. W. 4.*

Capitalization of Machine Company on Basis of Earnings

(New Jersey) Where a corporation was organized to manufacture and sell a certain patented machine in the United States, which at the time had become standardized on certain railroads, and it then appeared that the demand would necessarily increase, and new conditions which subsequently arose to render such machine less valuable could not then have been anticipated, capitalization on the basis of earnings for the preceding year did not constitute an overvaluation, so as to render stockholders liable to assessment on the subsequent insolvency of the corporation.—*Railway Review v. Graff Drill & Machine Co. 91 A. 1021.*

Sale of Second-hand Machinery

(Alabama) In the sale of second-hand machinery f. o. b. cars in good condition, there was no implied warranty of its reasonable adaptation to the uses for which it was bought.—*Johnson v. Carden, 65 So. 813.*

Action for Breach of Warranty

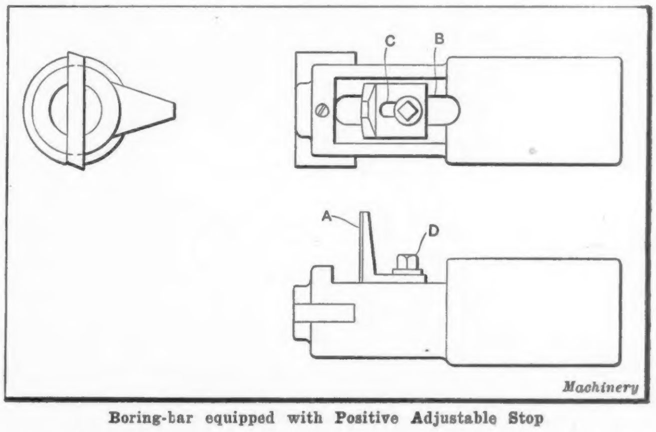
(Alabama) A buyer of machinery ordered for a particular purpose may accept it, and on breach of the seller's warranty of fitness for such purpose may maintain an action for breach of the warranty—*Western Union Telegraph Co. v. Jackson Lumber Co., 65 So. 962.*

* * *

POSITIVE STOP FOR BORING-BAR

BY HORACE R. GARDNER*

Where accuracy is required in the depth of a counterbored hole and the stops on the machine cannot be depended upon to give the required degree of accuracy, I have found that the device here described is very effective. I have used it on the boring-bar in a chucking machine, but the same idea could readily be applied to other machines.



Boring-bar equipped with Positive Adjustable Stop

Referring to the illustration, it will be seen that a stop *A*, which is made of hardened tool steel, is fastened to the bar to limit the depth to which the tool can cut. The working face of the stop is slightly rounded to avoid sharp corners that would cut the surface of the work. The stop is provided with a tongue which fits into the slot *B* in the bar to keep it from turning, and adjustment is provided by the slot *C*, the stop being set in the required position and held firmly in place by the cap-screw *D*. By using a little red lead or Prussian blue on the face of the stop to show when it touches the work, extreme accuracy can be obtained.

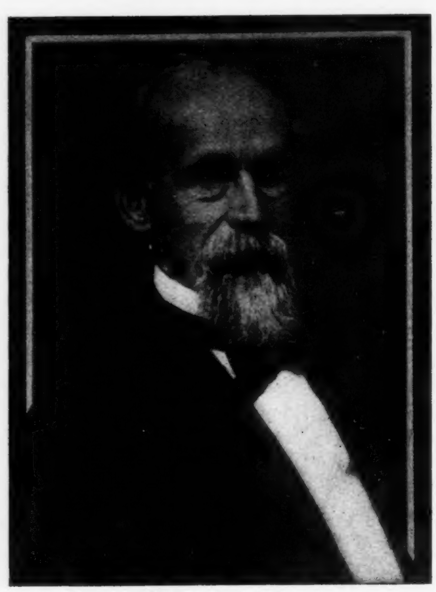
* Address: 179 Henry St., Detroit, Mich.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

EXTRACT PRESIDENT HARTNESS' ADDRESS—TECHNICAL PROGRAM—BIOGRAPHIES OF BRASHEAR AND SWEET

THE thirty-fifth annual meeting of the American Society of Mechanical Engineers was held in New York City, December 1 to 4 inclusive. It comprised the usual social and technical programs, including various excursions. The meeting opened Tuesday evening with an address by President James Hartness, and following the address was a reception in honor of the incoming president, John A. Brashear, and the retiring president.

The subject of President James Hartness' address was "The Human Element—the Key to Economic Problems." It pointed out that the world of mechanism has become so intricate and complex that it has gone beyond the capacity of any single individual to comprehend, and it is only by selecting the character and limiting the amount of material to be taken into the mind that we can hope to accomplish the best results. Specialization and repetition, by which habit is formed, are both essential to success. It is a fact that large organizations are essential as affording an opportunity for the most complete sub-division of work and the greatest degree of specialization.



John A. Brashear

Granting that the large organization is necessary in this age, not only in bringing out the best in the individual but in maintaining the supremacy of American industry against foreign competition, may it not be that we may approach the ideal in the large industrial plant? It was Mr. Hartness' belief that a large industrial plant should have capital equal to or as large as any competing organization. It should have a small harmonious board of directors with an able leader; and each executive should possess some special knowledge essential to the organization. As regards employes, each man should be treated in a respectful manner and needless direction or heartless correction by overbearing executives should never be permitted. Criticism or reprimand should not be uttered in the presence of others, for the best control of the organization comes from contact with the better side of man, and that side is not reached by those who ride rough-shod over a man's self-respect.

He pleaded for permanency of organization, pointing to the fact that investors look with distrust upon a management that is always changing officers, changing men, changing models, changing methods without regard to the inertia of habit and the human element which is the life-blood of every organization. They also look with doubt on any scheme of management that allows careless employment and discharge of men without due regard to the losses involved by such changes.

The technical program on Wednesday comprised the following papers and discussions:

"Floor Surfaces in Fireproof Buildings," by Sanford E. Thompson.

"Reinforced-concrete Factory Buildings," by F. W. Dean.

"Measuring Efficiency," by H. L. Gantt.

"Standardization in the Factory," by C. B. Auel.

"Operation of Grinding Wheels in Machine Grinding," by George I. Alden.

"Friction Losses in the Universal Joint," by P. F. Walker and W. J. Malcolmson.

"Steam Locomotives of Today" (Sub-committee report).

On Wednesday evening the John Fritz medal was awarded to Prof. John E. Sweet "in recognition of his achievements in machine design and his pioneer work in applying sound engineering principles to the construction and development of the high-speed engine."

On Thursday the following papers and discussions were presented:

"The Future of the Police Arm from an Engineering Standpoint," by Henry Bruere.

"Some Factors in Municipal Engineering," by Morris L. Cooke.

"The New Charter for St. Louis," by Edward Flad.

"The Engineer and Publicity," by C. E. Drayer.

"Snow Removal" (a committee report).

"The Design and Operation of the Cleveland Municipal Electric Light Plant," by Frederick W. Ballard.

"The Handling of Sewage Sludge," by George S. Webster.

"Training for the Municipal Service in Germany," by Clyde Lyndon King.

"A Study of Cleaning Filter Sands With No Opportunity for Bonus Payments," by Sanford E. Thompson.

"Factors in Hardening Tool Steel," by John A. Mathews and Howard J. Stagg, Jr.

"Standardization of Chilled Iron Crane Wheels," by F. K. Vial.

"The Mechanical Elimination of Seams in Steel Products, Notably Steel Rails," by R. W. Hunt.

Topical Discussion on Alloy Steels.

Thursday evening a dinner dance was given to members, visitors and friends at the Hotel Astor.

The professional session Friday morning was as follows:

"A Rate-flow Meter," by H. C. Hayes.

"Laboratory for Testing and Investigating Liquid Flow Meters of Large Capacity," by W. S. Giele.

"A New Volume Regulator for Air Compressors," by Ragnar Wikander.

"Physical Laws of Methane Gas," by P. F. Walker.

"The Clinkering of Coal," by Lionel S. Marks.

"Damages for Loss of Water Power," by F. W. Dean.

The excursions included an inspection of the *Lusitania* of the Cunard Line; Ellis Island; Hill Building; New York Telephone Long Distance Exchange; Brooklyn Navy Yard; The McCall Corporation; Biograph Moving Picture Studio; United Electric Light & Power Co., 201st St. Plant; Watson-Stillman Co.'s plant at Aldene, N. J., etc.

John A. Brashear

John A. Brashear, the newly elected president of the American Society of Mechanical Engineers, is known throughout the world as a manufacturer of astronomical and physical instruments. He was born in Brownsville, Pa., in 1840 and received a common school education. A traveling astronomer exhibiting the wonders of the heavens to passersby at five cents a look, gave the boy his first glimpse of astronomy, which became his passion. Following the example of his fellows, he learned the trade of patternmaking and at the age of twenty-two, was established apparently for life as a millwright in a Pittsburg rolling mill.

But unlike many other workmen about him, he was not content to work for bread and butter alone. He had recently married, and he and his ambitious young wife spent their evenings in the study of astronomy. Having no money to buy a telescope, they set to work to make one for themselves. In their little home, which they had built with their own hands, they set up a shop with a tiny engine and lathe and there made the tubes and ground the lenses, often working until midnight in the absorbing joy of the task, after a long hard day at the mill and in the home. Their first glass, a 5-inch one, took three years to grind, but being dissatisfied with its limitations, they set to work on a 12-inch glass, only to have it break in the silvering process after two years of patient grinding and correcting. The next glass proved successful, and its production was destined to be the turning point in young Brashear's career. S. P. Langley, then in charge of the Allegheny Observatory, had for some time

known of the young astronomer's work, and now began to entrust him with some of the observatory instruments. At the same time, certain astronomical articles written by Mr. Brashear had attracted the attention of William Thaw, one of the patrons of the observatory, and it was he who advanced the necessary capital that enabled Mr. Brashear to move to Allegheny, Pa., and set up a shop there. An account of the accomplishments of this shop would be a history of modern astronomy and without them much of that history could not have been written. Perhaps the most important achievement was in connection with the design and development of the spectroscope for astronomical uses, particularly with reference to the mechanical features.

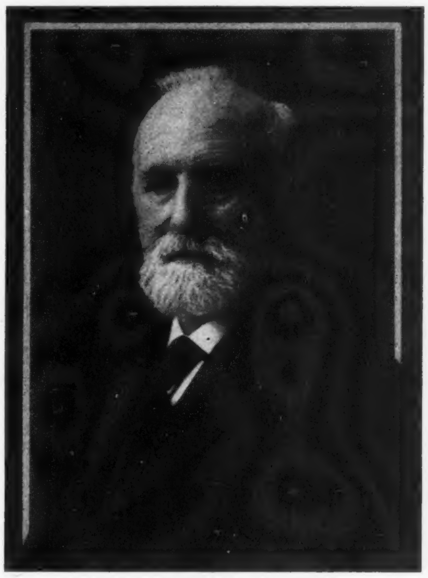
In 1888 Mr. Brashear completed the spectroscope for the 36-inch telescope, furnishing the mechanical parts only, the optical parts being secured from Prof. Steinheil of Munich. The complete small spectroscope was furnished by Mr. Brashear, including the prism and all other optical parts. It was found that better work could be secured with the small spectroscope than with the large one and that the optical parts were of higher grade than those obtained from Munich. The re-working of the optical parts of the large spectroscope was undertaken by Mr. Brashear with complete success.

The excellence of the work done at Lick Observatory is attributed to Mr. Brashear's skill and genius. His more purely scientific work also brought recognition, and about the time of his moving to Allegheny he was given an appointment in the University of Western Pennsylvania, of which the Allegheny Observatory was a department.

The John A. Brashear Co., Ltd., formed by Dr. Brashear with his son-in-law, James B. McDowell, in Allegheny, has from its beginning been devoted to the construction of apparatus for special work, rather than more commercially profitable products. It is the boast of the concern that it has no patents and no secrets, and that whatever it has accomplished is freely given to the world. The Allegheny Observatory is also unique in that it is put, in every possible way, at the disposal of the public through lectures and through access to the telescope and other similar means. These projects are typical of Dr. Brashear's attitude and spirit throughout his career. He was honored with the degree of LL.D. by Washington and Jefferson College and is a member of several scientific and engineering bodies.

John E. Sweet

John E. Sweet to whom the John Fritz medal was awarded in New York City Wednesday evening, December 2, was born at Pompey, N. Y., October 21, 1832. His boyhood was spent on his father's farm, and was given up to the varied work that a farmer's boy is called upon to do. He secured a common school education at the local schools of his native town, and at eighteen was apprenticed to learn the carpenter's and joiner's trade, his life thereafter being devoted chiefly to carpentry and building until he was nearly thirty. Meanwhile he had studied architecture and did considerable architectural work before the outbreak of the Civil War. In 1862 he went abroad, and while there he secured a patent on a nail machine in which the Patent Nut & Bolt Co. of Birmingham, England, took an interest. Mr. Sweet entered the employ of the company, and at that time began to write upon technical subjects, contributing to London *Engineering*. He returned to America in 1864, working as a draftsman in Syracuse, N. Y., on a varied line of machines. During this time he worked on a matrix impressing machine arranged with a keyboard, which was intended to do away with the use of movable type. This machine was the progenitor of the present linotype machine. In the early seventies Mr. Sweet conceived the idea of the "Straight Line" engine, which is inseparably connected with his name, and is perhaps his most characteristic piece of work.


John E. Sweet

His prominence as a national figure dates from his connection with Sibley College of Mechanical Arts of Cornell University in 1873. His connection with the university lasted until 1879 and in this period of six years he arose from a position of comparative obscurity to one of national prominence. Mechanical engineering as a department of organized education was a new thing. There were no precedents and regarding its practicability there was almost universal skepticism. Its plan, its scope, its aims, were unformed even among its friends—and its friends were few. There were no experienced educators.

Prof. Sweet's work was first that of a teacher, and second, that of a pioneer in mechanical construction. In the latter capacity he laid an enduring foundation for interchangeable manufacturing. His experience as a draftsman in England had shown him the fundamental importance of the work of Joseph Whitworth, which heretofore had found little appreciation in America. Combining a keen appreciation of Whitworth's advanced standards of accuracy with original conceptions of correct principles, he established a school of construction, the influence of which was far-reaching. Along with this went an application of art in design—not the art of organization, but the art of perfect adaptation to purpose. The "Straight Line" steam engine was an embodiment of the mechanical principles advocated by him.

Prof. Sweet was one of the founders of the American Society of Mechanical Engineers, and was elected its third president. He was later elected an honorary member. He was one of the judges on machine tools at the Chicago Exposition, and is well known as a contributor to the technical press on mechanical topics. He has always been keenly interested in technical education, and one of his great ambitions has been to establish a trade school where young men can be instructed in the mechanical arts in a way that will fit them to become mechanics. As a teacher he was one whose pupils became disciples, and this is testified to by the existence of an informal organization of men who call themselves "Prof. Sweet's boys." They gather year after year on the occasion of his birthday for an annual dinner with him in Syracuse.

* * *

THE VALUE OF PATENTS

The Swedish Patent and Registration Office some years ago compiled a table showing the percentage of patents in force in various European countries after a certain number of years from the time when the patent had been issued. As is well known, patents in practically all countries except the United States become invalid on account of non-working after a certain number of years, so that while the term of patents in most European countries is fifteen years, only six per cent of the total number of patents issued are in force at the end of the fifteenth year, in several countries, including Sweden; in Germany this figure is only 3.5, and in Great Britain, 3 per cent. Italy shows the smallest percentage of patents alive at the end of the fifteen years, there being only two out of every one hundred patents issued in force for the total number of years. No better example could be shown to indicate how few inventions are really of practical value, because it is safe to assume that nearly all the really useful inventions are kept alive for their full term by being properly worked. Another interesting fact is also brought out by the investigation referred to. The patents relating to the chemical field prove to have the longest longevity; next come the electrical patents. The patents which appear to be of the smallest value in proportion to the number issued are those relating to ordinary mechanical appliances—still another reason why the man who thinks he has made a wonderful invention of a remarkable mechanical contrivance should think twice before he wastes his hard-earned money on a patent.

FACTORS IN HARDENING TOOL STEEL*

STRUCTURE OF TOOL STEEL—TIME OF HEATING—SPEED OF QUENCHING IN DIFFERENT BATHS—EFFECT OF MASS ON HARDNESS AND OTHER POINTS OF IMPORTANCE TO THE HARDENER

THE phenomena of carburizing iron and hardening it by quenching have been known for many centuries, yet the explanation of hardening steel has not yet been given to the satisfaction of all. Many theories have been advanced and each has its adherents, but one can scarcely say that any generally accepted explanation exists. As recently as this year, two very interesting new theories were advanced at the May meeting of the Iron and Steel Institute of Great Britain. In what follows we are not so much interested in the theories as in the practice of the art of hardening and tempering tool steel, and we shall confine our attention to carbon steels, giving some consideration to the so-called special steels containing various alloys, usually below 3 per cent. We shall not discuss high-speed steels, nor the many low-carbon alloy steels, primarily of value on account of their tensile qualities but also, in many cases, of limited value for tools, especially those used for hot work.

Composition of Tool Steel

Tool steels are included within the range of 0.60 to 1.50 per cent carbon, but not less than 90 per cent of them fall within carbon limits of 0.75 to 1.35 per cent. They are usually made by the very old crucible process or the very new electric processes, and just now there is considerable discussion as to the relative merits of these methods. Carbon forms at least one definite compound with iron, Fe_3C, known as cementite. This is the hardest constituent in steel. Cementite exists in annealed steel associated with a perfectly definite quantity of iron, or ferrite, as it is metallographically known. This definite relation between ferrite and cementite yields the constituent pearlite, in which the cementite and ferrite may exist in a laminated or a granular condition. This aggregate contains a definite percentage of carbon, 0.89 per cent, and steel containing 0.89 per cent carbon in its normal condition is found to consist of nothing but pearlite when examined microscopically. In steel containing less than 0.89 per cent carbon the cementite associates with sufficient ferrite to form pearlite, and leaves the excess ferrite free in distinct microscopic grains or crystals. On the other hand, if the steel contains above 0.89 carbon, there is more cementite present than can become associated with ferrite, and the excess being unable to find a partner, so to speak, exists in separate particles, either granular or in a more or less perfect net work surrounding the pearlite. The definite percentage of carbon which yields a full pearlitic structure in the annealed or natural condition is known as the eutectoid composition. Steels of lesser carbon are called hypo-eutectoid, and steels of higher carbon are called hyper-eutectoid steels. We are indebted to Professor Howe for these names.

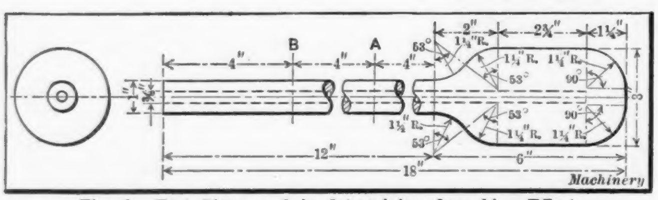


Fig. 1. Test Piece used in determining Quenching Effect of Various Baths

Effect of Temperature Changes on Structure of Tool Steel

When carbon steel is heated above a certain temperature, a change takes place in the constitution of the steel. This temperature is known as the carbon change point, critical temperature, or, preferably as the decalescence point. When this temperature is reached the pearlite becomes austenite, a solid solution of iron carbide in iron. This change occurs at a nearly constant temperature, but in the case of hypo-eutectoid steels, the austenite first formed above the decalescence point acts as a solvent for the excess ferrite. In other words, at a somewhat higher temperature than the decalescence point, we obtain a homogeneous solid solution of all the cementite in all the ferrite. This is the best condition for hardening a low-carbon tool steel and accounts for the practice of heating low-carbon steels hotter than hyper-eutectoid steels for hardening. The excess cementite of hyper-eutectoid steels is not readily soluble in the austenite first formed from the pearlite, and it requires a high temperature to complete the solution of the excess cementite. Practically considered, nothing is gained by doing so.

Steels quenched quickly from above the decalescence temperature retain the carbon more or less perfectly in the condition of solid solution that existed above the decalescence point. The structural name for the quenched product is martensite. Hypo-eutectoid steels, hardened, may show either all martensite or martensite and ferrite. Hyper-eutectoid steel should show martensite and cementite. The martensite of eutectoid steels has been called hardenite by Professor Arnold. Just as in the change of ice to water or of water to ice, there is an evolution or absorption of heat, so is there an absorption or evolution of heat in steel on passing through its critical range. There are several methods of determining this change point, but as these methods are so well known, we will omit detailed descriptions of the operations involved.

The position of this critical temperature is fairly constant in all straight carbon tool steels, but is affected to a variable degree by the addition of alloys. Just as the addition of salt to water lowers the temperature at which the solution freezes, so the addition of alloys lowers the freezing point of steel and frequently lowers the position of the critical temperatures. The addition of 10 per cent of nickel to a 1.00 per cent carbon steel, or of 4 per cent of manganese, for example, lowers the critical point to such an amount that steels of these types are martensitic at ordinary temperatures, even after slow cooling.

The determination of critical temperatures has materially assisted in the solution of many metallurgical problems. So far as we are concerned in this article, however, it is sufficient that for the practical hardening of tool steels this critical temperature must be exceeded by a fairly good margin, at least 25 to 50 degrees F., depending on the size, shape, mass and composition. On heating steel through its critical range changes occur other than those noted. Steel is strongly magnetic below the critical range, but loses its magnetism within and above. The electrical resistance for hard steel increases with the temperature up to the critical point in a curve which is nearly a straight line. On passing through, the resistance increases abruptly, and after having passed through, the increase per degree rise in temperature is very much less than in either of the other two cases. The specific volume of a hardened steel is approximately 0.01 greater than in its annealed condition. These marked changes in physical characteristics occurring at definite temperatures are indicative of the disturbances going on in the steel and occur at the temperature at which carbide carbon goes into solution on heating, or dissolved carbon is precipitated from solution on cooling.

Volume Changes in Tool Steel

The volume changes—both expansion and contraction—which occur during the critical ranges of temperature are of great practical importance to the hardener. The permanent changes in dimensions which steel undergoes in hardening are of the utmost interest to the hardener and associated with these changes is the problem of hardening cracks. It is an axiom that heat expands and cold contracts; but with steel there is a certain critical temperature at which an abnormal behavior is noticed, namely, a sudden shrinkage on heating and an expansion on cooling. The expansion of steel in heating to 750 degrees C., is about one-eighth inch per foot, and when we recall that, in quenching, a corresponding contraction attempts to take place suddenly,

* Abstract of a paper presented at the annual meeting of the American Society of Mechanical Engineers, New York City, December 3, 1914, by John A. Mathews and Howard J. Stagg, Jr.

it is little wonder that strains are set up that may exceed the ultimate strength of the steel.

What is the relation of the foregoing to over-heating, *i.e.*, heating above that temperature at which it is necessary to harden? After passing through the critical range, the expansion takes place at its maximum rate. When steel is heated in such a manner it assumes the shape corresponding to the maximum temperature, and on cooling the whole piece tends to return to, or near, its original size. In so doing, the outer or first cooled portion is hardened first and forms a hard, brittle, unyielding shell, and the strains set up by the slower cooling interior may either fracture the shell, producing external cracks (especially if the shell be uneven in thickness), or burst the piece at the center if the shell is of even thickness and strength. This latter occurrence is accompanied by a peculiar appearance of the fracture and frequently and wrongly called pipe.

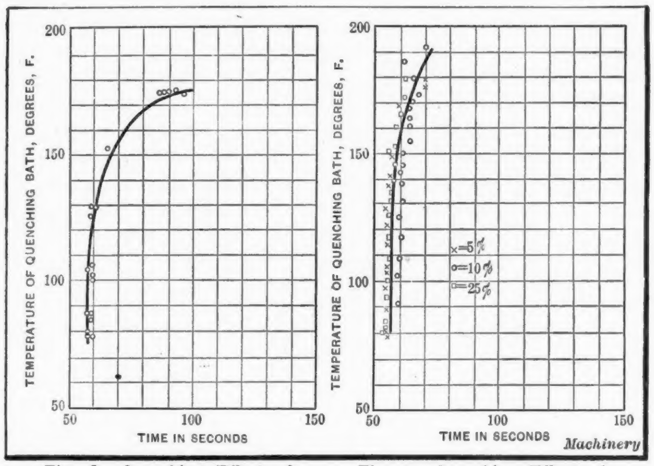


Fig. 2. Quenching Effect of Syracuse City Water

Fig. 3. Quenching Effect of Brine Solutions

Time of Heating

Too much stress cannot be laid on the fact that there is a correct length of time for heating tool steel and that this time of heating is as important as the temperature to which it is heated. There are at least two dangers which must be avoided. First, if the heating be too fast, a uniform temperature does not exist throughout the mass being heated. For example, a die block heated too quickly may exhibit the following conditions: The outer portions may be above Ac_1, and expanding at the maximum rate; the intermediate portions may be in the transformation range and contracting; while the inner portion, which is below Ac_1, is slowly expanding at the characteristic rate below Ac_1. What wonder that steel fractures under such conditions!

Second, grain size depends among other variables upon temperatures above Ac_1, and time above Ac_1. If heating be of such a character that the piece is held above Ac_1 for an abnormally long time, the crystals may have grown to such an extent that on quenching, abnormal grain size is retained and the result is a weak, if not cracked, piece. Quick heating in a furnace which is considerably hotter than the correct hardening temperature is extremely bad practice. The difficulty is that the thin parts, corners, and edges are liable to attain an overheated temperature before the larger portions of the piece attain the correct hardening temperature, and this overheating of the thin parts produces large grain size, abnormal expansion and tends to produce cracks.

Speed of Quenching

If a sample of steel is cooled slowly from above Ac_1 the solid solution which has been formed breaks up and precipitates its cementite and ferrite and we have then an annealed steel. If the cooling on the contrary is rapid, the solid solution is not given the time necessary to permit the complete dissociation into cementite and pearlite and we find formed the intermediate break down of austenite, known as martensite. If the cooling be intermediate in its speed between extremely slow and extremely fast, we find intermediate microconstituents such as troostite or sorbite. The correct constituent in a hardened steel is martensite, and to form this the material must be cooled quickly.

There are several degrees of "quickness" which at once suggest themselves. There is, however, a critical rate of cooling through the range which must be attained before the piece will be hardened. On quenching it is clear that the surfaces of the section are cooled and hardened first. If the mass being cooled is of considerable size, different degrees of hardness are noticed from the outside to the middle. The cooling medium used, its temperature, and condition affect the rate of cooling. Benedicks has investigated this subject and arrived at conclusions of extreme interest. He found that in order that a liquid present in large bulk may have a good quenching power it is necessary that it should possess a high latent heat of vaporization, and that it be maintained at a temperature low enough to avoid too abundant formation of vapor. High specific heat, low viscosity and large heat conductivity all act, it is true, in the direction of quick cooling, but the influence of the two factors previously mentioned appears to be of a different and lesser grade than the heat of vapor formation.

The authors have devoted considerable time to investigating numerous commercial quenching media which are in use in typical hardening plants of the country at the present time. The results given are only a small portion of those actually obtained, but they are typical. In attacking the problem, the following method was adopted: A test piece of the dimensions shown in Fig. 1 was machined from a solid bar, and a hole drilled through the neck to within an equal distance from each side and bottom of the test piece. Into this hole a calibrated, platinum-rhodium couple was inserted and the leads connected to a calibrated galvanometer. The test piece was then immersed in a lead pot, also containing a thermo-couple to the point *A*, and the lead pot was maintained at a temperature of 1200 degrees F. When the couple inside of the test piece was at 1200 degrees F., and the couple in the lead pot read 1200 degrees, the test piece was removed and quenched to the point *B* in 25 gallons of the quenching medium under consideration. At the start the quenching medium was maintained at room temperature. The time in seconds that it took the test piece to fall from a temperature of 1200 degrees to a temperature of 700 degrees was noted by the aid of a stop-watch. It is clear that immersing the test piece in the quenching medium raised the temperature of the medium. The test piece was

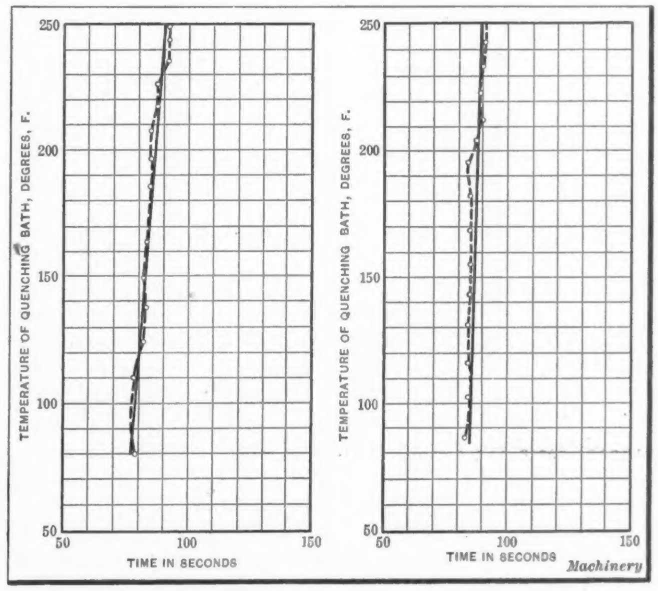


Fig. 4. Quenching Effect of New Fish Oil

Fig. 5. Quenching Effect of No. 2 Lard Oil

then replaced in the lead, heated to 1200 degrees, quenched into the medium at this higher temperature and the time again taken with the stop-watch. These operations were continued until the quenching media, in the case of oils, had attained a temperature of about 250 degrees F. The results obtained, time in seconds, for a fall from 1200 degrees to 700 degrees were plotted against the temperature of the quenching medium and a series of curves as shown in Figs. 2 to 13, inclusive, was obtained.

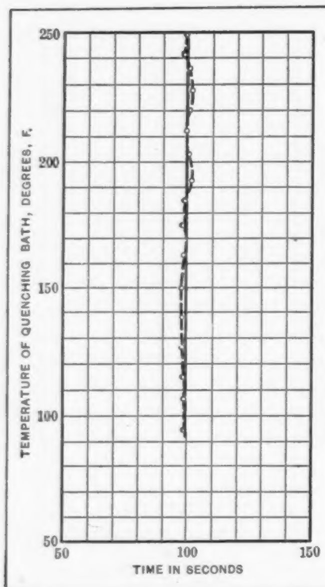


Fig. 6. Quenching Effect of Prime Lard Oil in Use Two Years

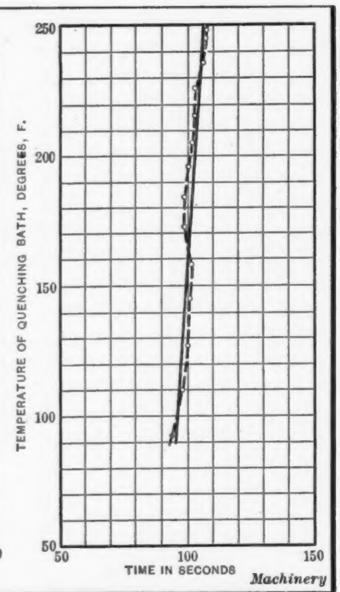


Fig. 7. Quenching Effect of Boiled Linseed Oil

A consideration of the results is interesting. Pure water (Fig. 2) has a fairly constant quenching rate up to a temperature of 100 degrees F., where it begins to fall off. At 125 degrees the slope is very marked. Brine solutions (Fig. 3) have both a quicker rate of cooling and are more effective at higher temperatures than water. The curve does not begin to fall off seriously until a temperature in the neighborhood of 150 degrees is reached.

As is well known, the oils are slower in their quenching powers than water or brine solutions, but the majority of them have a much more constant rate of cooling at higher temperatures than water or brine.

The curve shown in Fig. 13 is for a thick viscous oil somewhat similar to cylinder oil. This curve is particularly interesting in that it has a slower quenching effect at low temperatures than at higher temperatures.

A comparison of curves in Figs. 5 and 6, shows the variation in quenching effect of the same oil due to continued service. The differences in quenching rates may well account for different results from the same steel in different shops, or in the same shop.

Hardness as Affected by Mass

It has been known for some time that different masses of the same material on being quenched under like conditions give varying physical properties, but it is only within recent years that the quantitative effect has been measured.

In order to determine the effect of mass on hardness, test pieces 4 inches long were made from the same ingot in sizes increasing 1/8 inch in both breadth and thickness. The smallest was 3/8 inch square and the largest 3 1/4 inches square. Three ingots of different type analyses were chosen and a series of test pieces made from each. The test pieces were heated in a semi-muffle furnace to a constant temperature for each type of material, quenched, and the Brinell hardness test made. Each series was then drawn to 600 degrees F. in a salt bath and Brinell tests again taken. The pieces were then reheated to 1200 degrees in a salt bath and Brinell hardness tests again made. The results are partly shown in Fig. 14, the Brinell hardness being plotted against the test piece size. It will be noted that the smaller the sample the greater the hardness, indicating that the smaller sections are cooled with greater rapidity than the larger, and hence more hardness is developed. The same agencies are at work in tool steel. The larger the mass the smaller the depth of hardness when quenched under similar conditions.

Benedicks has shown that for steel of constant mass, the higher the temperature, the greater the rate of cooling. This confirms our experience that in order to produce the same amount of hardness in a small and large section, it is necessary to heat the larger section hotter than the smaller. A commercial application of this phenomenon will perhaps be interesting. The authors were recently confronted with the problem of finding out the correct temperature for hardening tools made from the same steel in sizes varying from 1/16 inch diameter to 3/4 inch diameter. The temperature-size curve shown in Fig. 15 was finally adopted. As the curve shows, a 3/16 inch round bar will harden at 1395 degrees F., while a 3/4 inch round bar should be heated to 1450 degrees—a difference of 55 degrees.

Expansion and Contraction in Hardening

One of the authors made several hundred hardening experiments and several thousand measurements to study the effect of hardening upon the shape of steel parts. The materials used were cylinders of steel and taps. Crucible steel alone was examined and the following variables were considered: (*a*) the effect of original form or diameter upon the diameter after hardening; (*b*) the influence of carbon on change of form; (*c*) the influence of initial temperatures at quenching; (*d*) the influence of length of time of heating; (*e*) the influence of repeated hardenings; and (*f*) the effect of annealing previously hardened steels, upon change of shape in rehardening. Obviously, when plain cylinders of steel are considered, there are four changes of shape possible, expansion in length and diameter, contraction in length and diameter, expansion in length and contraction in diameter, and contraction in length with expansion in diameter.

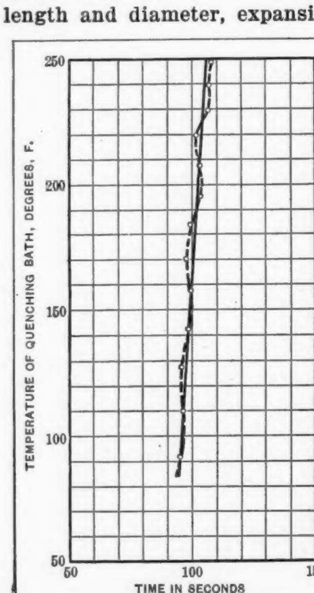


Fig. 8. Quenching Effect of Raw Linseed Oil

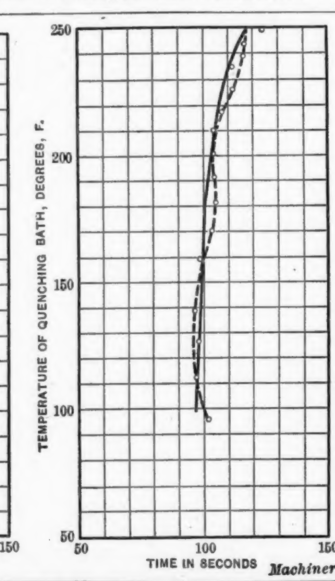


Fig. 9. Quenching Effect of New Extra-bleached Fish Oil

Under the influence of the variable conditions mentioned above, all four changes were actually produced. Steel was also found which expanded in length on first hardening and contracted indefinitely thereafter on repeated hardenings. Another steel expanded in length on two hardenings and contracted on the next two. In a variable carbon series of

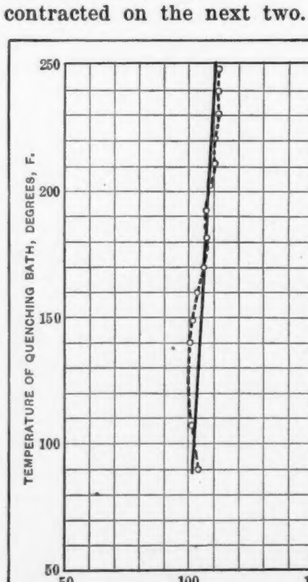


Fig. 10. Quenching Effect of New Yellow Cottonseed Oil

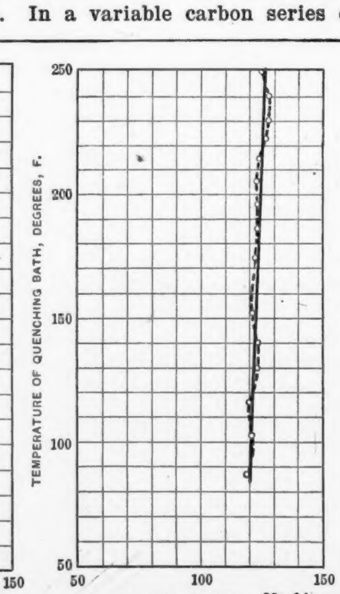


Fig. 11. Quenching Effect of New Tempering Oil

steels from 0.50 to 1.33 per cent carbon, the magnitude of the change in length after four hardenings increased as the carbon increased. For the same series it was noted that the volume changes were greater when hardening annealed rather than unannealed bars. The increase in length is greater, the higher the hardening heat for all carbon steels. It is variable conditions that give variable results; hence, it is of vital importance that steel be furnished uniform, chemically as well as physically, and it is equally important that the user employ every possible refinement in the handling of his product. It is only under varying conditions of heat, size, time, composition, etc., that the results vary. Constant conditions give constant results. It cannot be overlooked, however, that constant conditions are not always attainable. The maker of steel cannot control conditions in his customer's shop and the customer cannot control conditions in the steel plant, and the human element must be considered in both. The properties we have been describing are inherent properties of carbon steel, and because of them many a dispute has arisen over tools lost in hardening. The

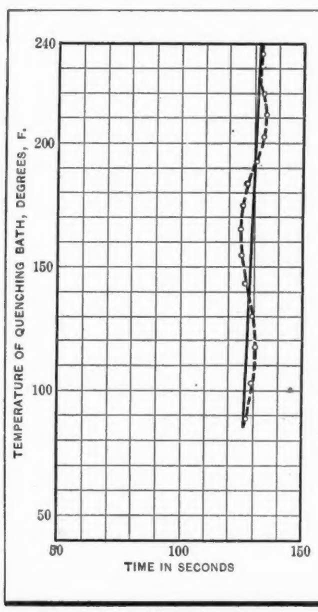


Fig. 12. Quenching Effect of New Mineral Tempering Oil

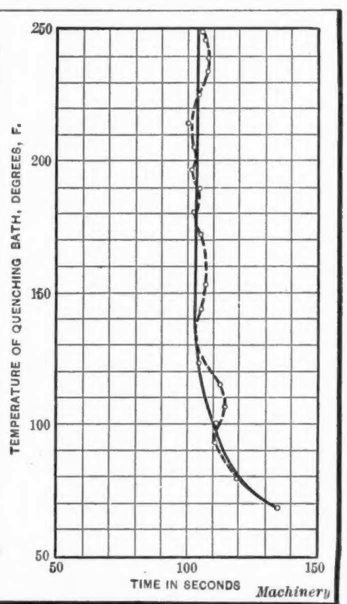


Fig. 13. Quenching Effect of No. 1 Dark Tempering Oil

placing of the exact responsibility is very difficult even though it were not true that it is human nature to shirk responsibility.

Furnaces and Methods of Heating

Much has been said regarding the superiority of gas furnaces over oil furnaces and *vice versa*. The fuel used is immaterial for good practice so long as the following points are taken care of:

1. The furnace and hearth should be of sufficient size so as not to be affected materially in temperature by the introduction of the parts to be hardened.

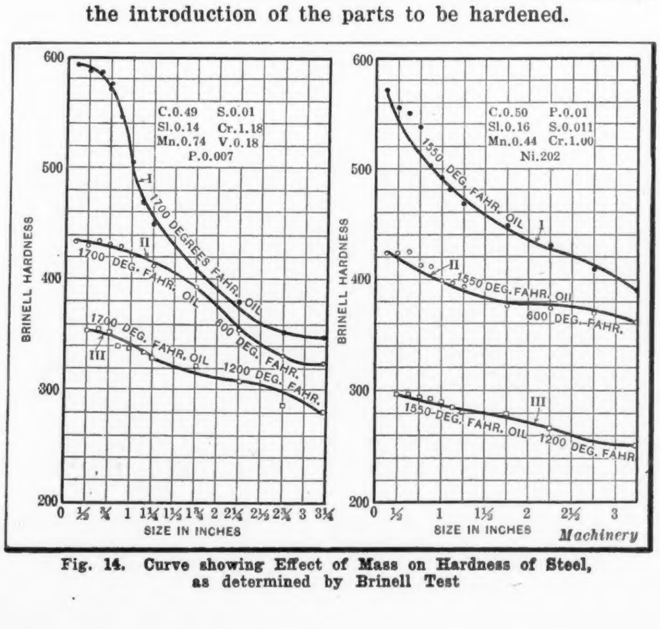


Fig. 14. Curve showing Effect of Mass on Hardness of Steel, as determined by Brinell Test

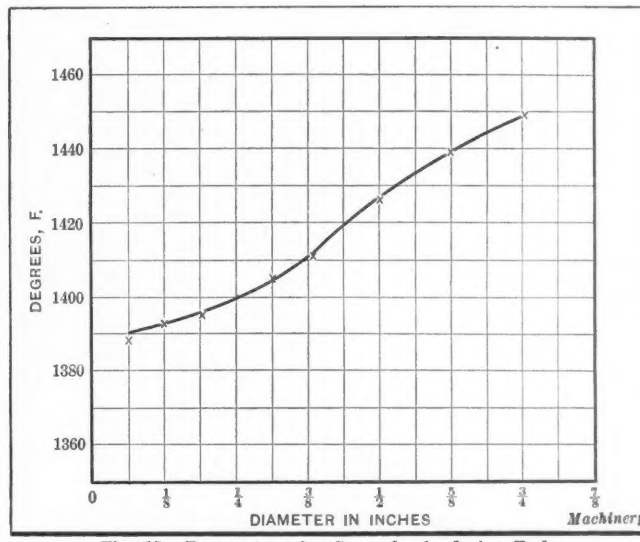


Fig. 15. Temperature-size Curve for hardening Tools

2. The furnace should heat at a uniform rate.
3. The furnace should be of uniform temperature over its entire hearth.
4. The furnace should be run under neutral, or reducing, conditions. A good rough test for this is the introduction of a piece of wood or paper upon the hearth. If the paper, or wood, burns, the atmosphere is oxidizing; if they char, it is reducing or neutral.
5. The temperature control must be at all times exact and it must be possible of exact duplication on repetition work.

A blacksmith's fire is satisfactory under good handling but the difficulty is that for constant work it is too exacting on the operator and requires too many manipulations to secure uniform and continuous results.

* * *

Public buildings are notorious for inefficient arrangement, utility having been sacrificed in their design to so-called architectural beauty. It is difficult to convince the average public building architect that utility and architectural grace can be harmoniously combined, but the great office buildings of New York City and other cities present many examples of handsome architecture and the highest efficiency for business purposes. With all these examples to copy, however, the new post-office in New York City adjacent to the great Pennsylvania R. R. station is an example of inefficient arrangement for public use. The unfortunate patrons of this mammoth structure must climb *twenty-seven* steps in order to buy a one-cent stamp. Why in the name of plain common sense should the architect and others responsible for the design and construction of this costly building have sacrificed its practical utility to the fancied impressive effect of a long flight of steps leading up to its portals? If the building had been designed to be rented for business purposes, we are sure that this blunder would not have been committed. Can not the same gage or measure of practicality be applied to public buildings?

* * *

An alloy may generally be defined as an intimate mixture of two or more metals obtained by melting them together. Most of these mixtures are mechanical in their nature, although some form chemical compounds. When two metals are melted together to form an alloy, the substance formed is, for all practical purposes, a new metal. Its appearance is different from that of the two or more original metals, and its properties, in general, are entirely different. Sometimes the alloy is harder than either of the ingredients, as, for example, brass, which is harder than either the copper or zinc from which it is made. One of the peculiar properties of nearly all alloys, which differentiates them from chemical compounds, is that the percentages of the composition may be changed within certain limits without materially affecting the characteristic properties of the alloy. In the case of the chemical compound, the proportions must always be the same.

SOME TYPES OF AUTOMOBILE CRANKSHAFT LATHES

UNIVERSAL MACHINES FOR THE CRANKSHAFT MANUFACTURER AND SPECIAL EQUIPMENTS FOR THE AUTOMOBILE BUILDER

BY WILLIAM O. STRAUSS*

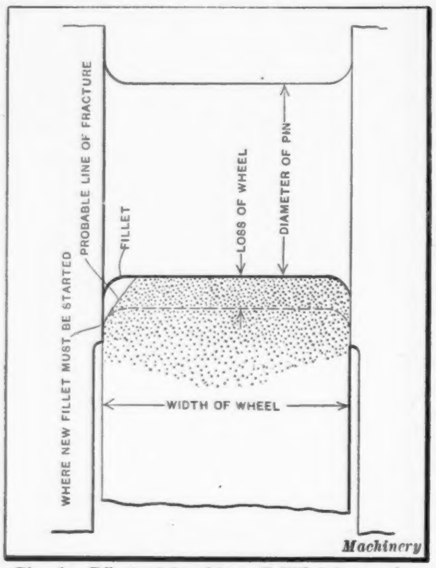


Fig. 1. Effect of breaking off Fillet in causing Rapid Waste of Wheel

MAKERS producing automobile crankshafts on a sufficiently large scale to warrant the purchase of special crankshaft machines may be roughly divided into two classes: First, those who are engaged in the manufacture of finished crankshafts for the trade, who do a contract business in the industry and require a flexible machine (type A) that is entirely universal within its range and capable of handling a wide variety of cranks for motors of both four and six cylinders. Second, the automobile builder who confines himself to a single model, simply requiring duplicate and practically automatic production on a large scale. His requirements are for a machine (type B), stripped of every degree of flexibility, that is capable of being quickly set up for a single job, and for which the investment is as low as is consistent with good materials and design necessary for the maximum production that the stability of the crank itself permits.

The economy of rough-turning crankpins preparatory to finish-grinding, as compared with rough-grinding, has been so thoroughly determined in the highly specialized shops that it needs but small mention here as a competitive proposition. The rapid disintegration of the coarse grained wheel from contact with the fins left from the forging dies, and the necessity of frequent re-dressing to maintain the fillets, as shown in Fig. 1, is a big factor from the standpoint of wheel upkeep, besides causing frequent delays in the production chain. By way of comparison, it is sufficient to say that a single set of properly treated high-speed steel tools will turn from 150 to 200 ordinary drop-forged or hydraulic pressed cranks, with a scleroscope reading of 35 to 40 degrees, without re-sharpening. The tools are held in removable blocks that are ground to gage and inserted after sharpening in a few seconds. In fact, an extra set is always kept sharpened and in reserve for instant use. The superiority of this method is now recognized by all of the larger manufacturers, while the crank grinder is considered the proper method for finishing the pins.

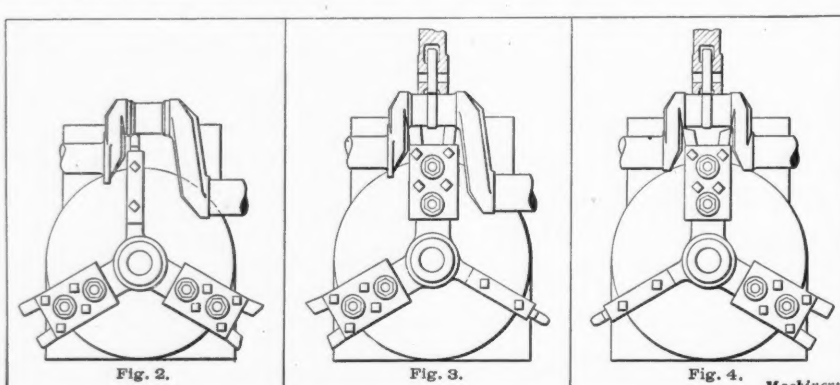


Fig. 2. Fig. 3. Fig. 4.

Figs. 2 to 4. Turning Pin, forming Fillets, and finishing Cheeks of Crankshaft

The Type A or Universal Machine

The type A machine, as mentioned before, is fully universal within its range and has a capacity for crankshafts up to and including a motor stroke of 6½ inches for four or six cylinders, the length of the crank being unlimited. This machine is a relatively recent development and has been carried out along entirely original lines. It has passed through many experimental stages, as the practice of the industry dictated, from an ordinary engine lathe with a throw block on the faceplate and a plain block rest to carry the tools, to the present machine. The novel and distinguishing feature is the indexing three bladed turret that carries the cutting tools, and the roller back-rest to absorb the thrusts, operated from a common handwheel through a telescopic screw, the other essentials being a universal indexing head and tail fixture for carrying the crank and a double-end drive mechanism to remove all torsion from the work and prevent twisting the pins out of alignment. The cranks before they are delivered to the machine are centered, the end and center bearings are roughed out to the proper grinding size, and the flanges are generally finished. They are then ready for the crank-pin turning machine.

The method of turning is as follows: The round nosed turning or spotting tool (Fig. 2) is first run into a positive cross-stop, sizing the diameter to within 0.015 or 0.020 inch of the finished size. The feed is then thrown in and the carriage fed along until the automatic stop lever engages a trip dog. The carriage is then returned against a positive stop by means of the carriage handwheel. This locates it for the filleting tools. The roller back-rest is next brought into position by means of the cross-feed handwheel, operating through a telescopic screw. This roller rest effectually absorbs all of the cutter thrust and prevents the shaft springing and riding over the edges of the tools. The turret is next indexed, bring the fillet forming tools into position (Fig. 3). These are then fed in against a stop, removing that part left by the turning tool and giving the pin the proper width fillets of the correct radius.

If the crankshaft is one with straight cheeks and these must be finished, the cheeking tools are next run in, giving the correct width between the cheeks (Fig. 4). These tools can also be used to remove any fins left from the forging dies

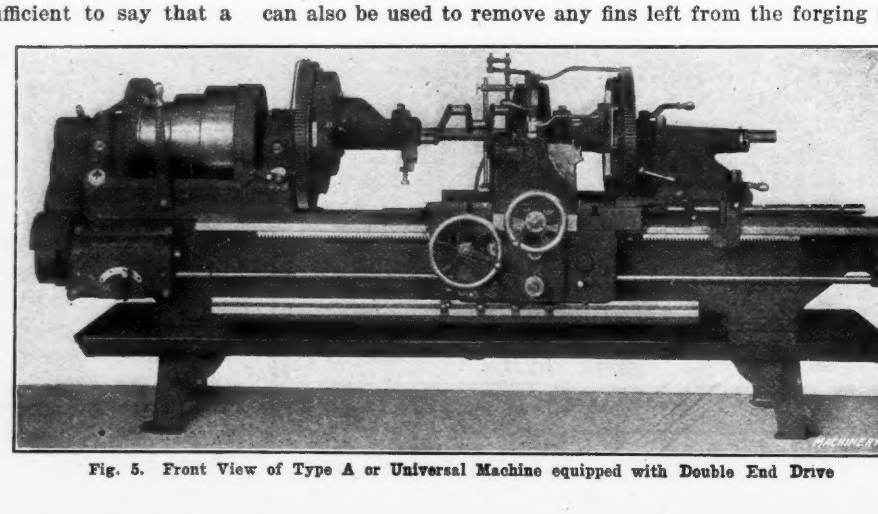


Fig. 5. Front View of Type A or Universal Machine equipped with Double End Drive

* With the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio.

in case there is no checking to be done. It will be noted that the roller rest is used on both the second and third operation. The back-rest is then run out of the way, the automatic stop lever raised, the carriage run down to the next pin in the same plane, and the sequence of operations repeated. After both pins in the same plane are finished, the head and tail fixtures are locked to maintain the setting, the clamp on the tail fixture opened, and the crank spun on its axis, bringing the next set of pins on the turning center of the lathe, then indexed and clamped from the head fixture.

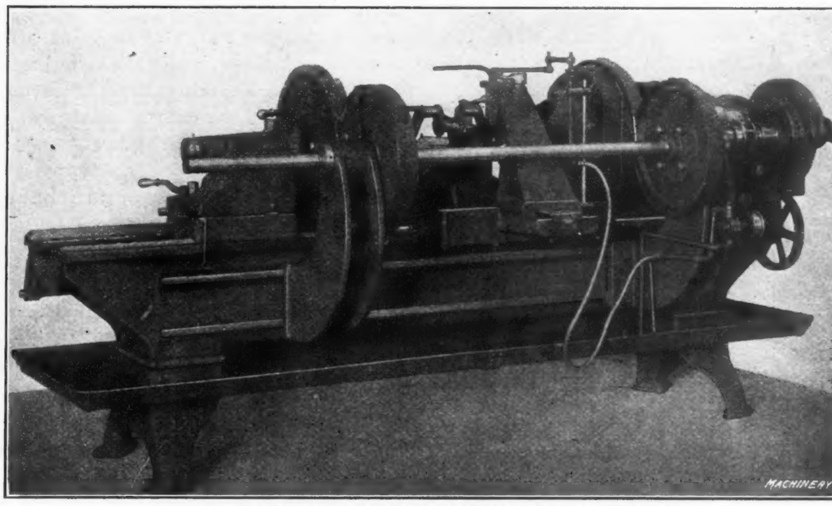


Fig. 6. Opposite Side of Machine shown in Fig. 5, illustrating Geared Connection of Head and Tail Fixtures

With the double-end drive machines discussed later, the locking plunger for the fixtures is unnecessary, as the alignment is maintained through the gearing. The index ring is provided with twelve slots, engine divided, enabling pins at every 30 degrees to be finished. This covers every condition for four and six cylinder cranks. The tools are carried in removable holders, and may very readily be removed and other tools substituted for different widths of pins; in other words, every single factor has been designed to render the lathe entirely universal within its limits and to enable the settings and adjustments to be made with as little difficulty as possible.

The Fixtures

The lathe to which these crank fixtures are applied is a 21-inch LeBlond heavy duty cone driven automobile lathe, with the well-known LeBlond double friction back-geared headstock, which enables the speed changes for the turning and filleting to be made without stopping; and in connection with an efficient double friction countershaft gives a selection of four speeds on each cone step while running. The spindle bearings are hardened and ground, the bearings are of chilled cast iron of unusual density and maximum wear resisting properties. The result is a practically indestructible bearing and the one suited to this severe class of work involving heavy intermittent shocks. The threaded spindle nose carries a heavy faceplate with a broad dovetail slide, on which the head fixture is mounted. This slide is graduated and the head fixture moved along by means of an Acme screw. The amount of throw is regulated in this manner, the adjustment being from zero to $3\frac{1}{4}$ inches throw or $6\frac{1}{2}$ inches stroke—sufficient to cover commercial requirements. After this adjustment is made, the tail fixture is set to coincide; and both fixtures are rigidly clamped by four T-slot bolts, or they may be dowelled into position. On long set-ups it is probably better to dowel the fixtures to the slide.

The head end crank carrier is provided with a hardened and ground index ring and plunger by means of which the fixture is indexed, bringing the different pins or sets of pins onto the turning center of the lathe. The index plunger is operated through a rack and pinion and has a radial and a taper face, drawing the index ring against the radial face by means of the taper, thus insuring the accuracy of the indexing mechanism. The plunger is held against the ring by means of a coiled wire spring. Bolts conveniently placed near the outside of the swivel effectively clamp the two members together after indexing. The fixtures are provided with hinged caps with renewable tool steel split bushing, by means of which cranks with different diameter line bearings are clamped in the fixtures. Before pulling the caps down tight, the crank is quickly centered by a V-block in the head fixture operated by the knurled head screw, which also serves as a driving dog for the crank. The tail fixture does not require an index mechanism, as the hinged cap is simply opened

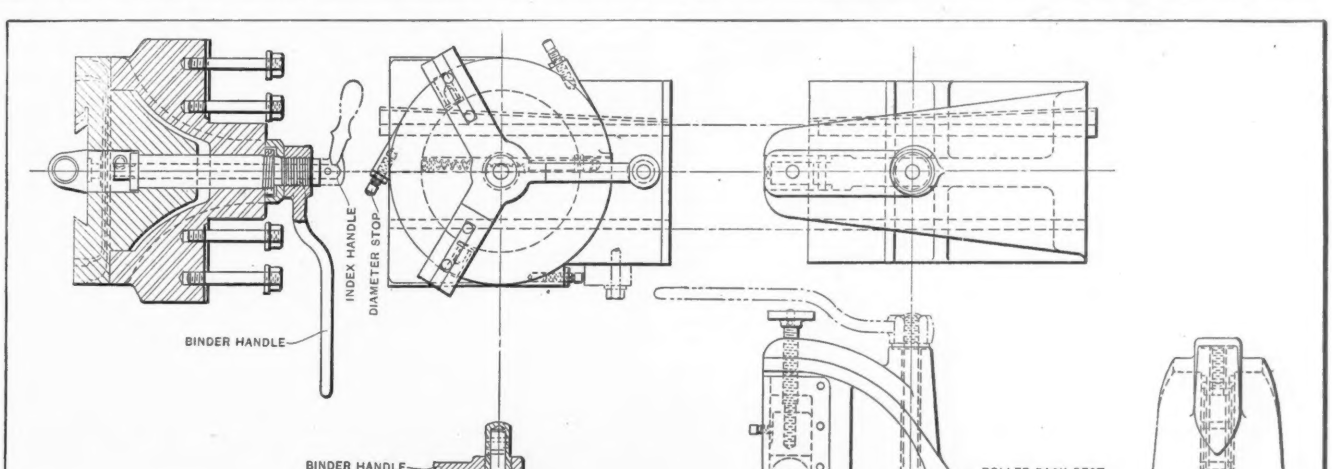


Fig. 7. Design of Three-tool Turret and Roller Back-rest for Type A Machine

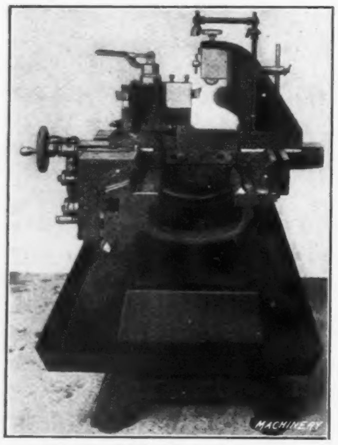


Fig. 8. End View of Type A Machine

and the crank allowed to rotate on its axis while the fixture is locked to the tailstock to prevent its weight tending to twist the crank. The spindle of the tailstock has been removed, and a new and larger spindle which carries the fixture has been provided. This spindle runs the entire length of the tailstock, revolves in bronze bushings, and is provided with a ball thrust adjustment on the rear end.

The Arrangement of the Double End Drive

The double end drive serves two purposes. First, it makes both ends of the machine drivers, and prevents one set of pins twisting in relation to the other. Second, it eliminates an operation necessary with a single end drive machine, *i.e.*, locking the two fixtures in alignment when removing and replacing the cranks, as the fixture alignment is maintained through the gear connection between the fixtures. Gear teeth are cut in the periphery of the fixtures on both the head and tail end. With these gears mesh a pair of accurately cut spur gears, connected by a splined shaft at the back of the lathe and paralleling its centers. These gears take liberal bearings in two heavily ribbed cast-iron brackets rising from a broad

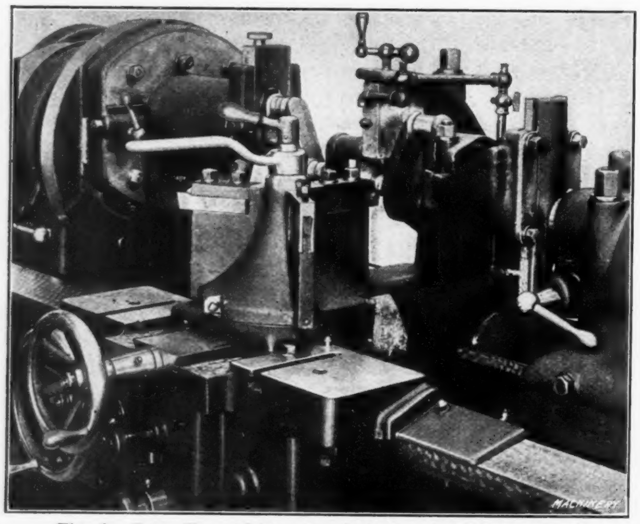


Fig. 9. Same Type of Turret and Back-rest shown in Fig. 7

planed dovetail cast integral with the bed, as shown in Fig. 6. The gear on the head is mounted on a flange keyed to the shaft and clamped in its driving position by four large studs set in circular slots in the web of the gear. This arrangement permits of adjustment in the alignment of the two fixtures and furnishes a means of compensating for wear in the gear teeth. The tail bracket is adjustable with the tailstock along the bed for different lengths of cranks. Both fixtures are of cast steel.

The Arrangement of the Turret and Roller Back-rest

The turret and roller rest construction is shown in detail in Fig. 7. A simple hardened jaw clutch arrangement enables both to be operated through the same handwheel by means of a telescopic screw, and the power cross-feed is available for both. The top roller of the back-rest is set in a sliding block operated by a knurled knob which enables the rollers to be quickly adjusted to the diameter of the crank-pin. Telescopic guards for the slide exclude all chips and dirt from the cross-slide and screw. The cross-slide is unusually wide to receive the tool-block and rest, both of which are accurately gibbed thereto. Positive locating stops and automatic length stops render the sizing of the pins practically automatic. The operators of these machines acquire a remarkable degree of proficiency in handling the turret mechanism, and are able to produce an ordinary four-throw crank turned, and the fillets formed, with an allowance of 0.015 inch for grinding and a limit of $\pm$ 0.003 inch in from 10 to 12 minutes each. A steel chip pan and large rotary pump permit of flooding the work with cutting compound. Outlines illustrating two types of cranks that are advantageously handled on the universal machine are shown in Fig. 10.

Type B or Manufacturing Machine for One Kind of Crankshaft

The style B or manufacturing machine is a newer development than the type A, resulting from the automobile manufacturers confining themselves to a single model, produced on a large scale and requiring only a minimum degree of flexibility. The most interesting feature is the fact that two

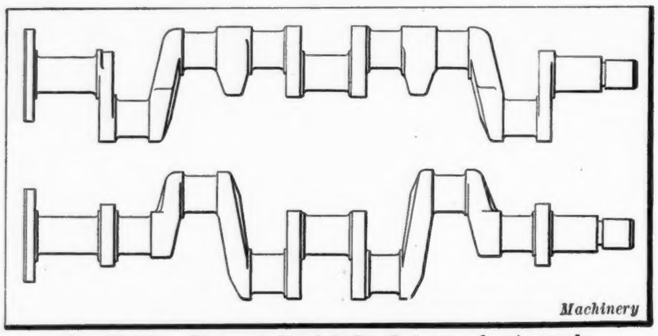


Fig. 10. Two Types of Crankshafts that are advantageously handled on the Universal Machine

pins, lying in the same plane and not necessarily adjacent, are finished at the same time. For a four-cylinder crank the equipment, of course, consists of two machines, one for the inside adjacent pins and another machine for the outside pins. The machine illustrated in Fig. 11 is for a crank of this kind. This type of construction increases the handling time, but the time saved by finishing two pins simultaneously, as well as the absence of any indexing operations, far outbalances the additional handling time incidental. As on the type A machine, the line bearings and flanges are finished on an ordinary automobile lathe before they are delivered to the pin lathe. The holes in the flanges are drilled and reamed to receive the flywheel, and the crank is aligned and driven from these holes by means of a hardened pin in the head fixture. As no index mechanism or adjustment for different strokes is required, the fixtures simply take the form of plain crank carriers with hinged caps. They are of cast steel to insure ample strength.

These cranks are of such design that they require no finishing on the cheeks, the tools simply consisting of the round nose turning tools on the front block and the tools for forming the fillets on the rear slide. The operations are as follows: The crank is centered by V-blocks in relation to the pins. The line bearings are roughed out and the flange finished, after which the flange is drilled and reamed. The

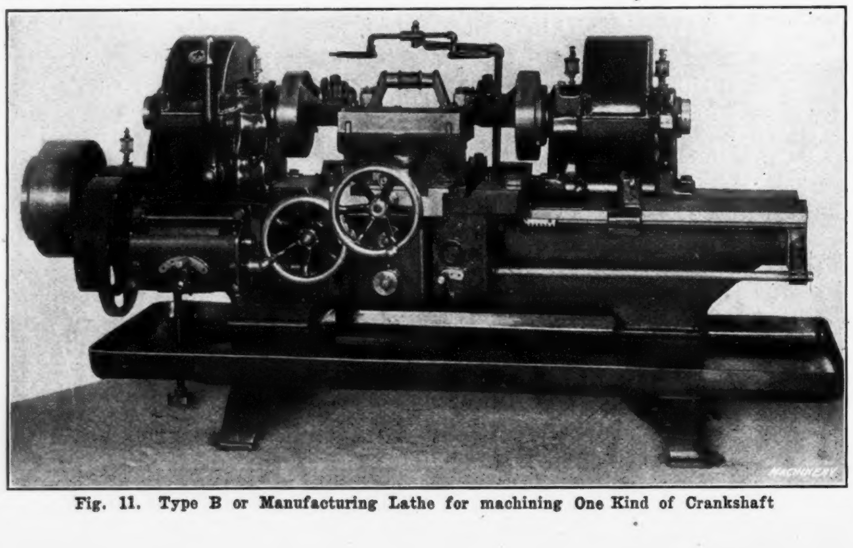


Fig. 11. Type B or Manufacturing Lathe for machining One Kind of Crankshaft

crank is then ready for the pin lathe. It is clamped in the fixture by means of the hinged cap on the fixture, and the pins are centered by the locating stud. The flange on the crank comes back to an end bearing on a shoulder of the locating stud, fixing the pins longitudinally. The round nosed turning tools are then brought in to a positive stop, sizing the pin diameter to within 0.015 inch to 0.020 inch of the finished size. The longitudinal feed is next engaged and the carriage fed along until it engages an automatic feed stop. The carriage is then returned against a positive stop dog in a spacing bar on the carriage, which locates the filleting tools, as well as the starting point for the turning tools on the next crank. The filleting tools are brought in to a stop, forming the radius and overlapping the traverse of the turning tool. It will be noted that this operation is going on with two pins simultaneously; as the machines are worked in pairs, both in operation at the same time, it is possible to finish a four cylinder crank complete in about two minutes. In fact, this is the rate at which they are being finished in one of the largest automobile shops in the country.

Both fixtures are positively driven through gearing. One of the large gears is mounted on a flange and is adjustable about its hub through a circular slot in the web, enabling the fixtures to be re-aligned or adjusted at any time. The initial drive is from a large pulley, carried on an oil bushing on the head end bearing stand. This pulley is clutched to the driving shaft which runs through the center of the bed, by means of a powerful friction clutch in its periphery, operated by the handle conveniently placed on the headstock. On releasing this clutch the same handle applies a friction brake, bringing the spindle to an instant stop. The driving shaft is carried in bronze bushed bearings in each head pedestal, and carries a pinion on each end between its bearings. This pinion drives both headstocks in unison, so that the crank is driven from both ends and has no tendency to twist under the cut. The driving shaft is of spindle steel, large in diameter, rigidly supported in long bearings, and runs at a relatively high speed, thus eliminating torsion. The reduction between this shaft and the spindle is approximately 4 to 1, as the crank is turned at a speed of about 50 feet or 100 revolutions per minute, so that the pulley runs at nearly 400 revolutions, thus furnishing ample driving power. It is 16 inches in diameter and carries a 5-inch belt. The pinions on the driving shaft mesh with accurately cut spur gears of broad face, to insure

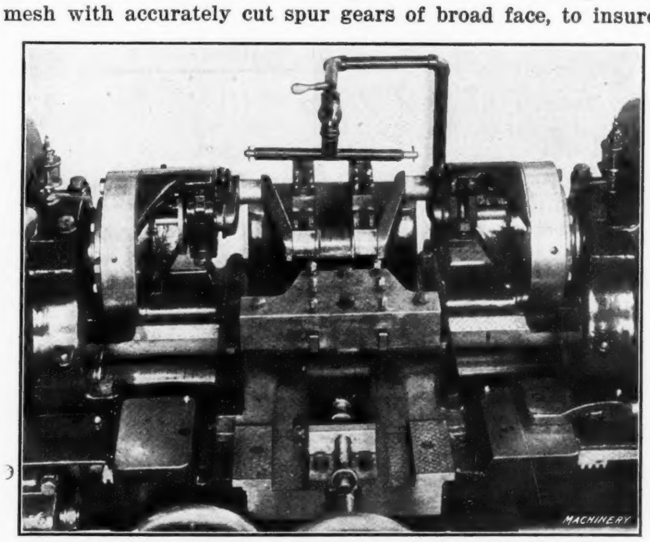


Fig. 12. Type B Machine tooled up for turning Inside Crank-pins

noiseless operation. To further reduce noise, the gears run continuously in heavy grease and are encased in close fitting cast-iron guards. The spindles are carried in relatively long bronze bushed bearings, with the front journals hardened and ground. The spindles are made from high carbon crucible forgings, with a large flange forged on to carry the crank fixtures, which are bolted and doweled to a false plate on the flange, so that the fixtures can be interchanged at any time.

The change gear box and apron are of the LeBlond standard construction for automobile work, and were described in MACHINERY some time ago. The carriage and bed construction, however, require some special mention. The carriage bridge is as wide as the widest spaced pins, and provides a support for the cut the full width of the tool-blocks. The slide takes a bearing the full width of the bridge, distributed over a wide dovetail and a square lock slide, and accurately gibbed thereto. This extremely wide bridge is permissible on account of the fact that the carriage does not travel over

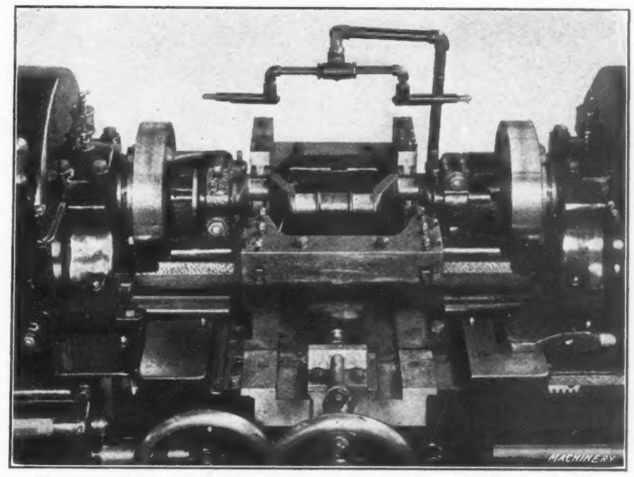


Fig. 13. Type B Machine tooled up for turning Outside Crank-pins

2½ inches at the most, the travel representing the width of the cut between the filleting tools. The carriage takes its bearing on the compensating shear of the LeBlond heavy-duty bed, giving a total of 227 square inches of carriage bearing surface. This is distributed over just three planes, on which the wear must be relative to maintain alignment. The front shear provides a right angle bearing to the tool thrust the full length of the carriage and a broad flat plane at the front and rear to take the down thrust. The total included angle of the shear is 85 degrees and gibs are provided front and rear. A double friction countershaft provides the necessary speed changes and a pan bed with a geared rotary pump and distributors enables the work to be flooded with cutting compound.

* * *

INDUSTRIAL CONDITIONS IN GERMANY

According to figures recently published in Germany, from reports of thirty-four labor unions with a membership of over a million and a half, 21 per cent of these are out of employment. In some trades, as much as 62 per cent of the men are unemployed. Considering the fact that a large percentage of the members are employed in the war, this would indicate that practically all of those that are at home are out of work. Only in the ammunition industries and a few allied trades is employment general. The automobile builders, for instance, are, according to the *Scientific American*, working twenty-four hours per day in an endeavor to keep up with the demands of the army. In many of these factories there is difficulty in carrying on the work, as so many of the skilled workmen have been called to the front, and in spite of the fact that there are so many people out of work, it is difficult to secure skilled labor to take the place of those in the field. In some cases, the employes of shops engaged on government contracts have been sent back to their works, in order to enable the work to be completed. A number of factories have been taken over entirely by the government and some of those near the scene of activities are devoted entirely to repairing damages sustained in action. This is particularly the case with factories in Belgium. Difficulties are encountered in securing supplies of rubber for tires and in the transportation of materials required.

* * *

It is stated in a French contemporary that it has been determined by experiments that a layer of electrolytically deposited copper from 0.001 to 0.002 inch thick is the most advantageous coating agent for protecting portions of steel to be casehardened from carbonization. Nickel cannot be used instead of copper because it is permeable to carbon monoxide.

TAYLORISM AND THE BONUS SYSTEM*

BY W. L. MYLES†

In the November number of MACHINERY, on page 191, there appears an article by Frank Richards entitled "Taylorism and the Bonus System," in which he very strongly denounces the methods of the Taylor system of pay for the mechanic. He agrees with the *London Engineer* in an article in which they speak of this system as a "peculiarly hideous method of dehumanization." He also states that it is far from having the ultimate effect of working in the interest of either employer or employe, that it deliberately brings about the degradation and belittlement of the individual workman and paralyzes all incentive. In some respects I agree with him most heartily, and give him credit for the courageous way in which he makes his denouncements. A good many of our so-called scientific systems of management are so loaded with red tape, useless forms and rules that I doubt if the money and labor they claim to save ever reach the amount of the cost of their maintenance. For it hardly seems possible to produce a man with the required ability to enable him to prescribe from the office exactly how the work in the shop should be performed by the mechanic, because conditions and materials are constantly changing. Even if this man has the shop training of today, tomorrow's methods of work may be entirely different, so his instruction and method of work would be out of date and inefficient. Again, the red tape necessary to go through in handling the work and using the prescribed tools, etc., goes to hinder more than help the man doing the job. It destroys confidence in himself and takes away all incentive.

To Mr. Richards' reference to the bonus system I most strongly object, and think that he misrepresents the basic principles of the true bonus plan of rewarding labor. After nearly eight years of practical experience with the differential bonus piece-work system I am thoroughly convinced that his views are entirely wrong. From the statements he makes in his article, one would be led to think that the increased production under the bonus system was due solely to the efforts of the mechanics, and they therefore should receive all the money saved. The mechanic himself does not expect this, and knows that in any extensive system of efficiency the overhead charges of maintaining such a system are no small item, and should receive their just portion of the profits, as the good results obtained from this system are from the close observation and cooperation of both brain and hands. Mr. Richards also states that the bonus system dodges the honesty of the men. This is entirely a mistaken idea. The bonus system is a means of affording substantial justice to the employe who is willing to put forth his efforts, requiring him at the same time to conform to the best interests of his employer. It is a known fact that 90 per cent of the working men of the country are doing less than 60 per cent of what they might do without physical injury or over-exertion. Under the day's work plan, all men classed as mechanics are paid a like amount per day, but in most cases you will find that there are a few men who are doing 50 per cent more than the rest. I would ask Mr. Richards if in this arrangement of pay he thinks there is any justice for the conscientious hard worker. No, there is none. If the bonus system was introduced into a shop for no other reason than that of rewarding the worker who is worthy, it is well worth while; but this is only one of its benefits.

Not only is this system a means of rewarding labor, but it is a material factor in cost accounting. We have long given up the practice of taking the foremen's guess or even the expert estimator's figures as to what a job will cost. We know under the bonus system, from the records we have made, just what that job will cost us before we undertake it. We have heard of instances where a man has boasted of his ability to read men and tell just what they are capable of producing, but the bonus system has taught us to place little faith in such claims. We all can make guesses and some of us can come very close to knowing just what a machine we are building will produce, because we know what material and workmanship goes into it; but who can know or even guess the capabilities of man, when his mind has been properly trained and his hands experienced? This is what the true bonus system tends to do, and not to doubt the honesty or rob the workingman of his share of the profits. When the bonus system was introduced in our shop we made a guess as to what percentage of efficiency we were receiving from the men for the amount of pay they were receiving on the day's work plan, and the records of results obtained under the bonus system showed conclusively that we favored the men in our guess.

One of the main questions not entirely solved by the manufacturer is, how are we going to increase the mechanic's efficiency, keep him satisfied and successfully reduce the manufacturing costs, enabling us to meet the keen competition in business? Suppose we advance the wages of labor say from 10 to 25 per cent, would we receive that proportion in increased output? No, not on the average, as a large percentage would not do any more work than before the advance. They would simply take it as a matter of fact. That is human nature. In all probability we would do exactly the same if we were in their place and working under the same conditions. I am convinced that in the mechanic lies the power to increase or materially decrease the cost of manufacturing and that such a result is best attained by taking him into your confidence, treating him as a fellow human being and not as a machine or know-nothing, as is the custom in many shops. Cooperate with him, give him the benefit of the executive ability which you have been fortunate enough to acquire, and in all probability he will surprise you by his hearty cooperation. Both employer and employe will become more efficient in their respective positions as a result.

The bonus system benefits the workingman because of the chance afforded him to show his individuality; he does not have to divide the spoils or honors with some other fellow worker who may not have put forth the same amount of energy in accomplishment of the task, but nevertheless receives the full reward. It benefits the workingman by reducing to a large degree the physical effort formerly put forth in accomplishing his task, for under this system he is instructed and directed as to the best method of performing his work, and by following as far as possible these instructions and directions he soon realizes that by the cooperation of his hands and brains less physical effort is required. This system frees the mechanic from the drudgery of purely routine work and puts new interest and energy into him. It arouses and cultivates that zest for reasonable racing, with the possible chance of beating his fellow workmen, and before long he has unconsciously reached a higher level of efficiency and consequently increased his earning capacity.

To prove to the skeptical manager, and also to Mr. Richards, that the bonus system actually produces results in securing lower production costs, higher wages, increased efficiency and a better quality of work, I could make mention of many cases where such an end has been obtained under this system. But the mentioning of a few cases will suffice. From the records of different operators on bonus for a period of six months, results were obtained which are shown in the table. This shows a total average increase for all of 0.064 cent per hour or 26 per cent higher wages. Another striking example of efficiency which came to the writer's notice was that where a gang of eight men worked on an assembling job for a period

RESULTS OBTAINED WITH THE BONUS SYSTEM

Class of Operators	Average Day Rate per Hour	Average Bonus Rate per Hour	Average Increase in Rate per Hour	Per cent Increase
Lathe	0.30	0.365	0.065	21.7
Planer	0.325	0.39	0.065	20.0
Drill Press	0.225	0.28	0.055	24.5
Milling Machine	0.187	0.242	0.055	29.4
Screw Machine	0.162	0.216	0.054	33.3
Boring Mill	0.342	0.43	0.088	25.7
			0.064	25.76

Machinery

* For additional information on the bonus system and allied subjects published in MACHINERY, see also "Taylorism and the Bonus System," by Frank Richards, November, 1914, and other articles there referred to.

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of several weeks, their average day's work rate per hour was 32 cents, but while on bonus they averaged 45 cents per hour —an average increase of 13 cents per hour or about 40 per cent higher wage. How do you account for such an achievement? Consider another case in point. A task, after a careful and detailed study was made of it, was put on bonus with a time allowance per piece 47 per cent less than it took to do each piece on day work. When the task was finished the time was reduced 54 per cent less than the time allowed, *i.e.*, the task was completed with a time reduction of 101 per cent less than it took on day work, with an average increase for the mechanic of 18 cents per hour or 48 per cent higher wage. This was due partly to the change of routine and method of handling the work, and proves beyond a doubt that the bonus system is not entirely a system to increase the workingman's efficiency alone, but likewise obtains and maintains a higher degree of efficiency throughout the whole organization, for its basic principles are cooperation, reward and greater efficiency. If we were to try today to eliminate the bonus plan of pay from our works, we would find it difficult to make our men satisfied with the resumption of the day-work plan.

* * *

CAUSES OF EXPORT TRADE

It is probably a puzzle to many Americans why England, Germany and France have, in the past, obtained such a firm hold on South American trade, while the United States has hardly had a chance at it. The answer, however, is simple. England, Germany and France have supplied the capital by which the railroads in South America have been built, and many of the industrial improvements been made. It is estimated that in the seven years from 1906 to 1913, Great Britain supplied the Argentine Republic with nearly $600,000,000 for developments; Brazil with $440,000,000 and Chile and other South American countries with $250,000,000. The total British investment in South America is reckoned at about $3,000,000,000. Germany and France have also supplied vast amounts of capital, although less than Great Britain. The United States has not invested capital in these countries because all the available capital here can find profitable employment at home.

Now what has the investing of money in a country to do with securing trade? It has everything to do with it. In the first place, the investors have probably obtained positions as directors in large industrial undertakings and railroads in South America, and naturally they have directed the trade channels to their own countries; but this may have been a minor influence. The most important cause is that when Great Britain, Germany and France have been selling goods to South America they have, to a large extent, invested the purchase price in these countries; that is, they have sold the goods on credit. The individual merchant may have received his pay, but England or France or Germany, considered as a whole, has not been paid. In other words, the transaction is like that of selling goods to a farmer and taking a mortgage on his farm in part payment of the bill. Evidently, under those conditions, the South American countries would do business with such nations as were able to transact business with them on this basis. The capital in the United States has had no need to go (to any large extent) outside of its boundaries for investment; hence there has been no incentive to sell goods on this basis.

* * *

ELECTRICAL CONGRESS POSTPONED

The executive secretary of the International Engineering Congress which is to be held in San Francisco, September 20-25, has issued a statement in regard to the International Electrical Congress which was to be held in San Francisco in September at the same time as the International Engineering Congress. Owing to the European war and the impossibility of convening the International Electrotechnical Commission, under whose authorization the Electrical Congress was to have been held, it has been decided by the governing body of the American Institute of Electrical Engineers to indefinitely postpone the holding of the Electrical Congress. This, however, does not affect the International Engineering Congress, which will be held as originally planned.

COST OF MUNITIONS OF WAR

At this time when the principal nations of Europe are at war and the question of increasing the defenses of the United States is being agitated, a few figures on the costs of guns, etc., will be of interest. The following data on the cost of guns, howitzers, mortars, mountings, carriages, projectiles, powder charges and fuses were furnished by the ordnance departments, Washington, D. C., and are therefore authoritative.

3-inch field gun	$ 1,825.00
4.7-inch field gun	4,650.00
4.7-inch howitzer	2,150.00
6-inch howitzer	3,325.00
6-inch seacoast gun	6,700.00
12-inch seacoast mortar	11,000.00
14-inch seacoast gun	55,000.00

The costs of carriages and mountings for seacoast guns are:

15-pounder barbette	$ 5,000.00
5-inch barbette	13,500.00
6-inch barbette	14,000.00
6-inch disappearing	24,000.00
10-inch disappearing	37,000.00
12-inch disappearing	65,000.00
14-inch disappearing	85,000.00
16-inch disappearing	130,000.00
12-inch mortar	18,000.00

The cost of artillery carriages of the mobile or transportable type follows:

3-inch field gun carriage	$ 2,181.00
3.8-inch howitzer carriage	8,500.00
3.8-inch gun carriage	5,462.00
4.7-inch howitzer carriage	10,562.00
4.7-inch gun carriage	4,361.00
6-inch howitzer carriage	14,147.00

If manufactured in the government plant, a round of ammunition costs approximately as given in the following, but when purchased from manufacturers, the cost is higher.

3-inch field gun	$ 10.00
4.7-inch gun	28.00
6-inch howitzer	43.00
3-inch, 15-pounder	15.00
6-inch	60.00
12-inch gun	500.00
12-inch mortar	300.00
14-inch gun	800.00
16-inch gun	1,200.00

The smokeless powder for seacoast ammunition costs 53 cents a pound when purchased and somewhat less when manufactured by the government.

Following are data on the cost of naval guns, carriages, etc.

3-inch naval gun	$ 3,973.00
5-inch naval gun	7,600.00
7-inch naval gun	21,850.00
12-inch naval gun	72,820.00
14-inch naval gun	112,000.00
3-inch gun mounting	2,500.00
5-inch gun mounting	9,860.00
7-inch gun mounting	11,000.00
12-inch gun mounting	52,357.00
14-inch gun mounting	44,000.00
3-inch projectile	1.97
5-inch projectile	8.72
7-inch projectile	62.00
12-inch projectile	165.00
14-inch projectile	400.00
3-inch gun powder charge	2.12
5-inch gun powder charge	9.40
7-inch gun powder charge	30.60
12-inch gun powder charge	147.40
14-inch gun powder charge	201.40
3-inch gun fuse	0.80
5-inch gun fuse	1.45
7-inch gun fuse	4.80
12-inch gun fuse	4.80
14-inch gun fuse	4.80

The cost of a torpedo is $8500 and of the explosive $350.

A navy rifle complete costs $20; pistol, $18. The navy pays 53 cents a pound for smokeless powder and 14 cents a pound for black powder.

The following data of costs of armor-plates and shells have been compiled from bids of private concerns:

4-inch naval gun shells	$ 9.50
5-inch naval gun shells	12.00
14-inch naval gun shells	415.00
7374 tons armor-plate, per ton	435.00
401 tons armor-plate, per ton	486.00
290 tons armor-plate, per ton	466.00
63 tons armor-plate, per ton	376.00

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

DRILL JIG FOR MACHINING HALF HOLES

A rather unusual form of jig for drilling a half hole in the work to match a similar half hole in another piece is shown in Fig. 1. This is a familiar device which is employed when it is desired to assemble two pieces and drive a pin into the hole to act as a driver. To drill such a half hole, it is usually necessary to plug up the hole in the work in some way which will back up the side of the drill that is not cutting. This is accomplished in the present instance by having a stud *A*, which is a push fit in the work, back up the drill. An angle iron or plate *B* is attached to the stud *A* and held in position by a bolt *C*, the plate *B* being also doweled in place. A hole is drilled in this angle iron to receive the bushing *D* which guides the drill in the usual manner. The remainder of the jig consists of the key *E* which locks the jig in place on the work.

In using this tool, the key *E* is pulled back clear of the work and the stud *A* which carries the angle iron is pushed into the hole until the stud brings up against the shoulder of the work. By pushing the tapered key *E* up until it binds on the flat of the work, and then tapping it lightly, the jig is held securely in place. When drilling one of these half holes it is found that if an ordinary twist drill is used there is a tendency for it to "hog in," which is likely to result in breaking the tool. For this reason, it is desirable to use a straight fluted or farmer's drill of the form shown at *A* in Fig. 2; although good results may also be obtained by taking a twist drill and grinding the lips to the form shown at *B*, thus removing the hook resulting from the spiral form of the flutes. A drill which is ground in this way presents a square or slightly obtuse cutting edge to the work, thus doing away with the trouble experienced from drills breaking when ground in the usual way.

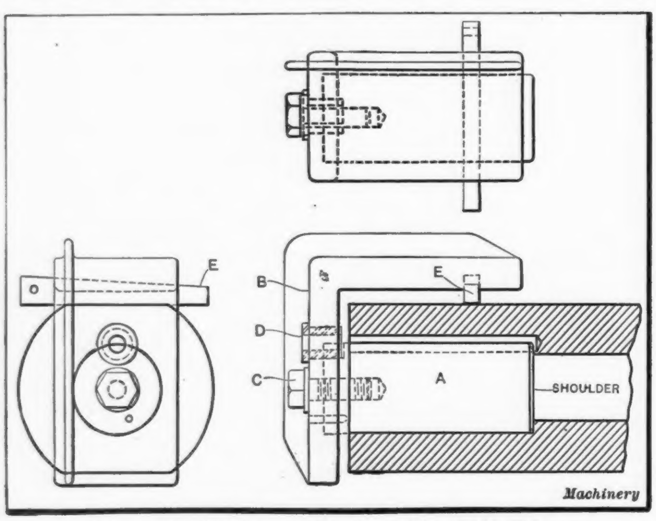


Fig. 1. Useful Form of Jig for drilling Half Holes

When drilling the hole, the work is set up on end on the drill press table and the drill is fed through the bushing in the usual way, the bushing holding the drill in position until it starts to cut. As the drill is fed down, there is a tendency to force it away from the work, but this tendency is resisted by the hardened stud *A* so that the half hole must be drilled parallel with the axis of the work. This jig affords a convenient means of quickly accomplishing this work and having the two half holes match up accurately, so that no difficulty is experienced in assembling the work. F. SERVER

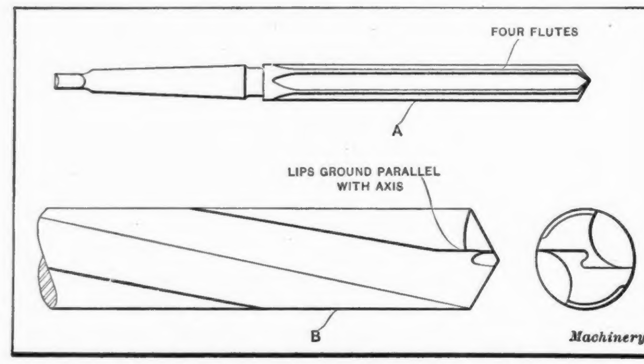


Fig. 2. Straight Fluted Drill A and Method of grinding Twist Drill B, for Use in Jig shown in Fig. 1

HOBBING SMALL GEARS ON THE MILLING MACHINE

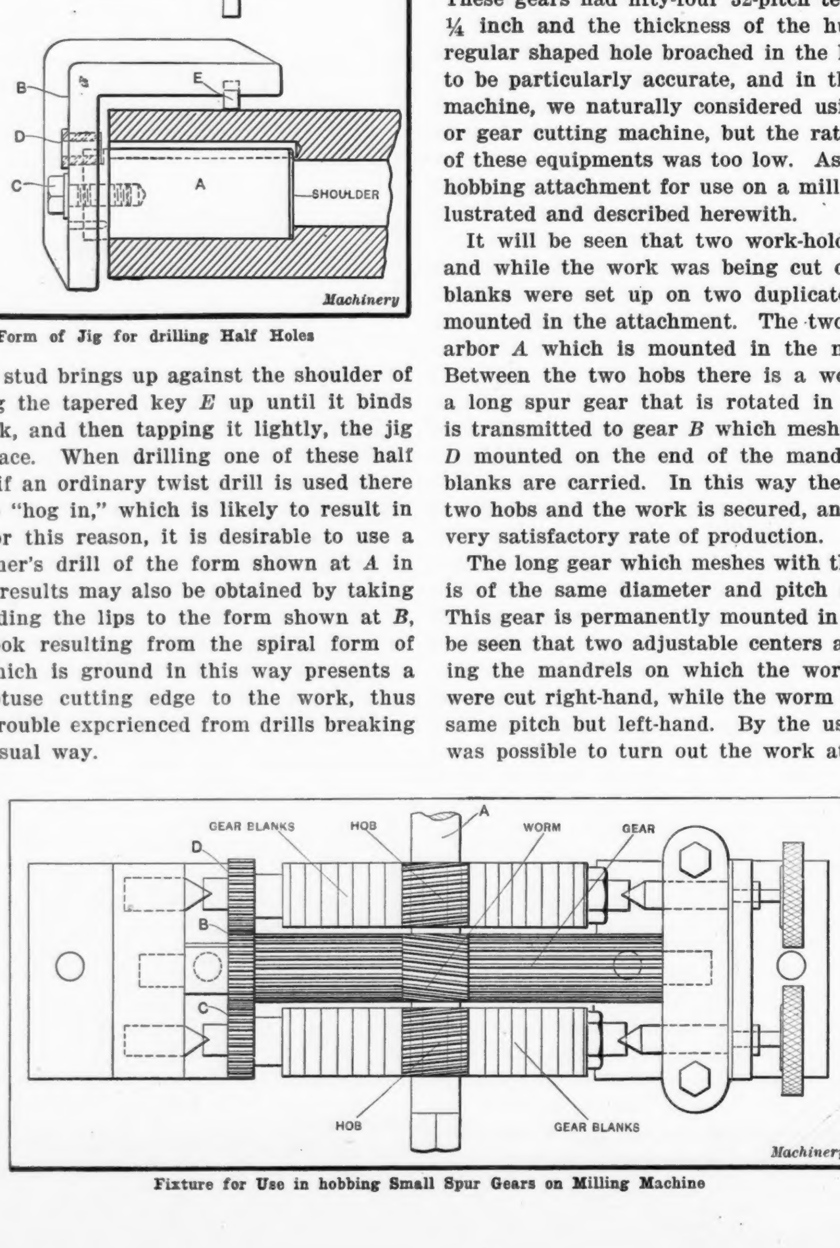
Not long ago we started on a new class of work which required a considerable number of small spur gears to be cut. These gears had fifty-four 32-pitch teeth; the face width was 1/4 inch and the thickness of the hub 1/2 inch, with an irregular shaped hole broached in the hub. They did not have to be particularly accurate, and in the absence of a hobbing machine, we naturally considered using the milling machine or gear cutting machine, but the rate of production on both of these equipments was too low. As a result, I designed the hobbing attachment for use on a milling machine which is illustrated and described herewith.

It will be seen that two work-holding mandrels are used, and while the work was being cut on these mandrels other blanks were set up on two duplicate mandrels ready to be mounted in the attachment. The two hobs are carried on an arbor *A* which is mounted in the milling machine spindle. Between the two hobs there is a worm which meshes with a long spur gear that is rotated in this way: The motion is transmitted to gear *B* which meshes with the gears *C* and *D* mounted on the end of the mandrels on which the gear blanks are carried. In this way the desired rotation of the two hobs and the work is secured, and the gears are cut at a very satisfactory rate of production.

The long gear which meshes with the worm on the arbor *A*, is of the same diameter and pitch as the gears to be cut. This gear is permanently mounted in the attachment. It will be seen that two adjustable centers are provided for supporting the mandrels on which the work is carried. The hobs were cut right-hand, while the worm on the arbor *A* is of the same pitch but left-hand. By the use of this attachment, it was possible to turn out the work at the rate of one gear a minute.

Although the attachment described in the foregoing was made especially for use on a Brown & Sharpe plain milling machine, it will be readily seen that it could be employed on various other types of milling machines with equally satisfactory results.

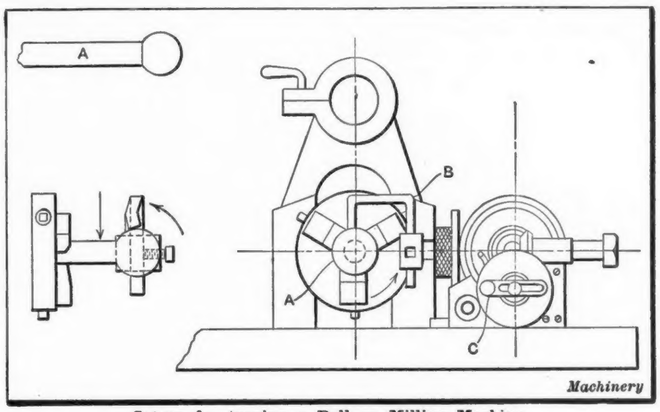
GEORGE WERNER, JR.
Newark, N. J.



Fixture for Use in hobbing Small Spur Gears on Milling Machine

TURNING A BALL ON THE MILLING MACHINE

On numerous occasions I have been called on to produce balls for socket joints, spherical reamers, end-mills, etc., and I handled this work on a lathe equipped with a compound rest. However, I was never satisfied with the results obtained in this way, and finally hit upon the method described in the following. On one occasion I had to make several pieces of the form shown at *A*, which were to be used in the clutch mechanism of a certain type of power press. I first turned the shaft to the required size and roughed out the ball as well as I could on the lathe. Having proceeded to this point, I bent a piece of good tool steel to the shape shown at *B*, and placed this tool in the milling machine fly cutter which was mounted in the index head. I then placed a chuck on the machine spindle, put the finished shank in the chuck and lined up the work with an indicator. Having proceeded thus far, I brought the tool into contact with the rough ball, after which the cut was started, turning the work and the tool in the directions indicated by the arrows. It will be evident that the tool was rotated by turning the crank *C* on the index head. By the use of this method, a very nice ball was easily obtained.



Set-up for turning a Ball on Milling Machine

It is important to have the tool cut on the front edge with the work rotating in the direction indicated in the illustration. If the tool cuts at the back edge it will tend to dig into the work and spoil the finish. If there are several pieces of one size to machine, after setting the tool to cut the correct size and finishing one piece the table can be moved to the left to enable the finished work to be removed from the chuck and a fresh blank mounted in its place. After this has been done the table is brought back to a stop which lines up the center of the sphere with the center of the cutting edge of the tool. By this means, the necessity of moving the tool is done away with.

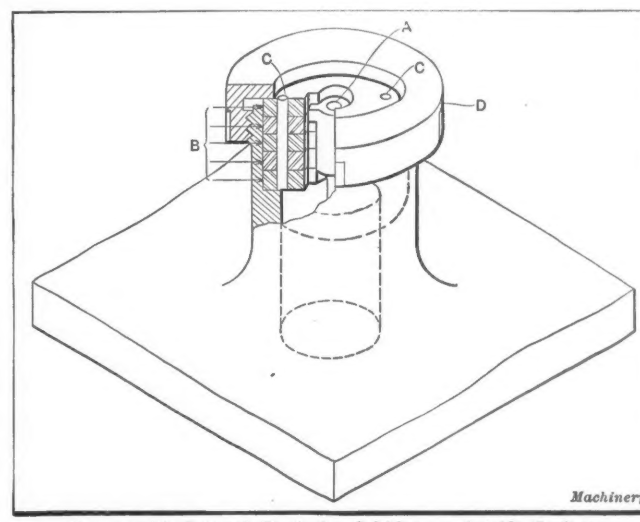
In machining a spherical shaped end-mill for milling the ball, I turn the shank very close to the required size and insert it in the milling machine collet, after which the collet is placed in the spindle of the milling machine. After turning and fluting the ball to a size within 0.0005 inch over that required, I harden the work and then grind the shank to the correct size. After this has been done, the work is stoned until it fits the templet accurately.

George Slider
New Haven, Conn.

EXTERNAL BROACHING

The subject of broaches which have their cutting edges located internally has received comparatively little attention. Generally it is better to accomplish the forming of exterior surfaces by other means, but in some cases the ability to do a successful job of external broaching will be a means of accomplishing a material reduction in manufacturing costs. In the accompanying illustration an internal broach is shown with the work to be broached passing through the cutting teeth at *A*. The teeth consist of disks *B* of the proper form, which are held in the desired relation to each other by the two dowel pins *C*, and the whole tool is held in the fixture base by tightening the nut *D* with a spanner wrench.

This broaching is performed after milling the rear end of the work in order to insure that it is true with the forward turned portion, and that the size is kept within very close limits. The punch in the spindle of the arbor press is made to fit the hole in the rear of the work and a tray under the machine catches the work as it leaves the broach. The results obtained in this particular case have warranted an extension of the idea to other operations of a similar nature, with some creditable savings in the cost of production and a bettering of the quality of work produced.

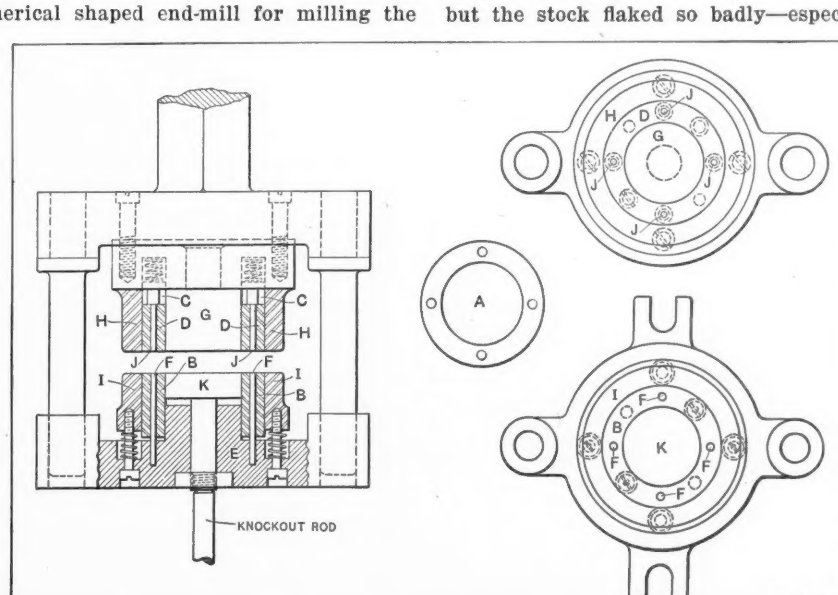


Broach with Internal Teeth for finishing an Outside Surface

Hart Ford

SUB-PRESS FOR BLANKING MICA INSULATORS

While employed by an electrical concern I was confronted with the problem of blanking and piercing the holes in mica insulators of the form shown at *A*. A plain die was tried out, but the stock flaked so badly—especially when the dies got the least bit dull, and they wore very rapidly owing to the abrasive nature of the material—that it was evident a more effective method would have to be developed. After giving the matter some thought, the sub-press shown in the illustration was designed, and as the stock was held flat and gripped between the upper and lower dies, the tendency to tear the material while blanking out the insulator and piercing the holes was eliminated.



Mica Insulator and Sub-press for handling this Class of Work

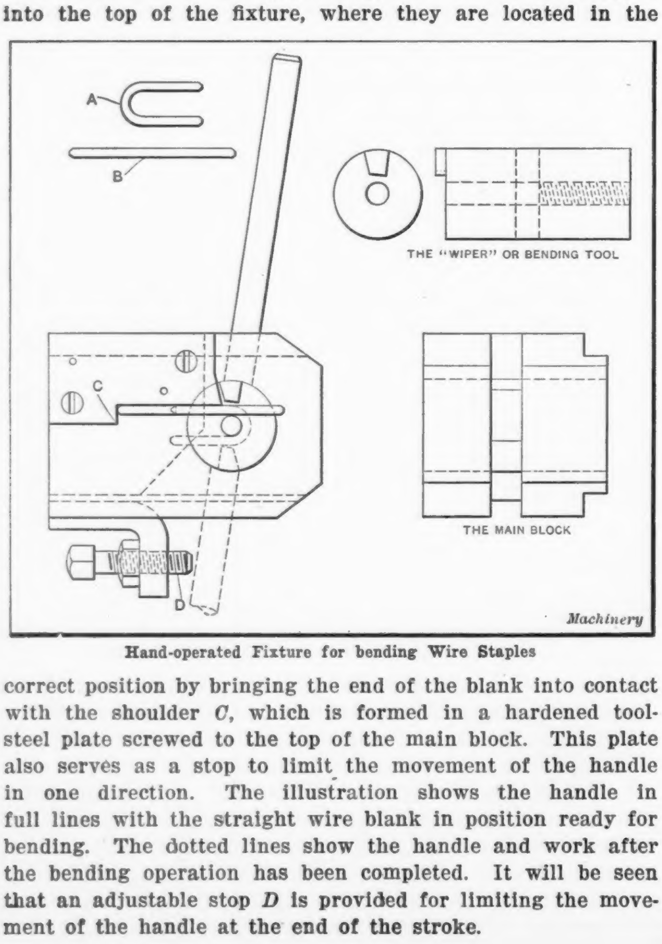
In operation, the upper die or punch descends, and as the springs under the die *B* are weaker than the rubber buffer *C* behind the punch *D*, it follows that the die *B* will be pushed down until it is stopped by the bolster *E*. It will be seen that the piercing punches *F* are held fast in the bolster *E*, and when the die *B* is depressed these punches enter the holes in the blanking punch *D* and pierce the four holes in the insulator. The large hole in the insulator is cut out and the complete insulator is blanked from the stock at the same time, this result being obtained through the action of the punches *G* and *H*, and the die *B*. The reason for having the die *B* work up and down is that it is normally at the same level as the piercing punches, thus affording an easy means of grinding and of presenting a perfectly flat surface on which to place the mica. In addition, the holding action required to prevent tearing the stock is obtained by having the work held between the upper and lower dies while the four small holes are being pierced. The piercings on the four small holes are pressed back into the stock, and the large center piercing is blanked and also pressed back into the stock, through the combined action of the knock-outs *I*, *J* and *K*.

All working parts of this punch and die should be made a close fit, as a little flaking of the stock is bound to take place, and if there is any clearance such flakes are likely to wedge in the working parts of the tool and cause trouble. In addition to its use on mica, a die of this kind could also be used for working celluloid or very thin sheet metal, where enough compression could be procured by the rubber buffer to resist the piercing action. The buffer is made of sufficient length to afford the necessary compression behind the upper die.

New Britain, Conn. W. C. Betz

WIRE BENDING FIXTURE

During an experience covering some twenty years I have met few toolmakers who have had much experience in making hand-operated fixtures for bending or forming wire. As a result it has occurred to me that a description of a tool of this type, which operates in a somewhat unusual way, would be of interest to readers of Machinery. This fixture is used for bending U-shaped wire staples of the form shown at *A*. Blanks *B* of the proper length are cut off and dropped into the top of the fixture, where they are located in the



Hand-operated Fixture for bending Wire Staples

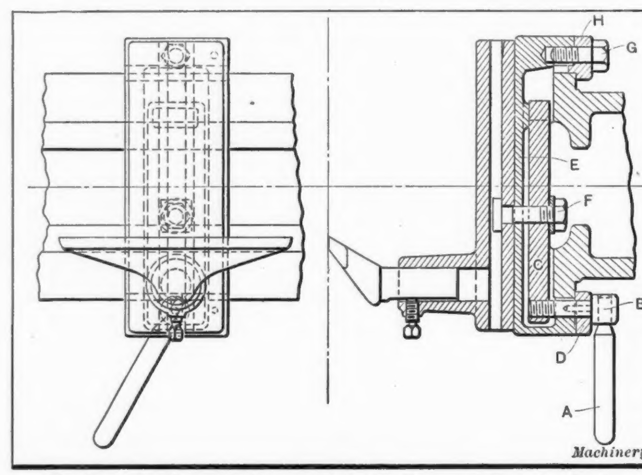
correct position by bringing the end of the blank into contact with the shoulder *C*, which is formed in a hardened tool-steel plate screwed to the top of the main block. This plate also serves as a stop to limit the movement of the handle in one direction. The illustration shows the handle in full lines with the straight wire blank in position ready for bending. The dotted lines show the handle and work after the bending operation has been completed. It will be seen that an adjustable stop *D* is provided for limiting the movement of the handle at the end of the stroke.

An interesting feature of this fixture is that the wire is not positively clamped or held during the bending operation. The plate in which the shoulder *C* is formed holds the wire against sidewise movement, while the "wiper" or bending tool draws it around the mandrel. The "bite" of the wiper is depended on to draw the wire forward. The design of this tool enables work to be produced very rapidly, and an idea of the rate of production will be gathered from the fact that a boy working on a piece-work rate of five cents per hundred would have little difficulty in earning from $2.50 to $3 in a ten-hour day.

Arlington, R. I. George P. Breitschmid

IMPROVED TURRET LATHE HAND-REST

In machining certain parts of brass and other relatively soft metals the use of a hand-rest is found to be the means of greatly increasing production. The accompanying illus-



Hand-rest for Turret Lathe provided with Improved Clamping Device

tration shows an improved form of turret lathe hand-rest which I have found by experience to increase the rate of production for those classes of work for which it is adapted. The saddle is locked in position on the bed and the cross-slide in position on the saddle by a single movement of the binder lever *A*. This lever is within easy reach of the operator and enables him to adjust the position of the tool-rest very rapidly.

It will be seen that the binder bolt *B* is threaded into the clamp *C* and that by turning the binder lever the binder bolt is turned in the clamp. The front cap *D* has a bearing on the under side of the saddle and the bed of the machine. Turning the binder lever causes the binder bolt to draw this front cap *D* up against the bed, thus clamping the saddle in place. The rear end of the clamp *C* bears against the saddle *E* and when the binder lever *A* is thrown over it will be seen that the front end of the clamp *C* is drawn down. This draws down the clamp bolt *F* which is responsible for clamping the slide in the required position.

To remove the hand-rest from the machine, it is merely necessary to unscrew the cap-screw *G* about 5/16 inch. This allows the cap *H*, which is held by this screw, to be released from under the lathe bed. The saddle is then moved out until the front cap will clear the bed, after which the entire hand-rest can be removed as a complete unit. It will be evident from this description that there is no danger of parts of the rest getting lost during the time that it is removed from the lathe.

Cincinnati, Ohio. William P. Winters

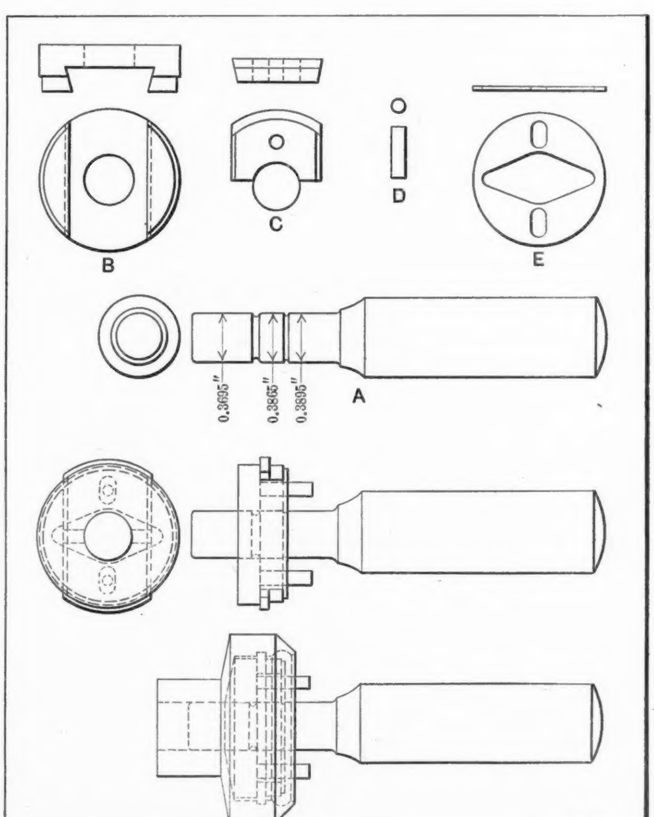
QUICK METHOD OF CUTTING RUBBER TUBING INTO RINGS

The other day I was called upon to cut some 2½-inch soft rubber tubing up into rings ½ inch in width. As it was necessary to have the ends of these rings perfectly smooth and at right angles to the walls of the tubing, it appeared that I was "up against it." However, after experimenting for some time I hit upon the following kink which enabled me

to turn the rings out quite rapidly and still maintain the required quality of work. The method consisted of forcing a round piece of wood lengthwise through the rubber tubing, the size of the wooden rod being such that it expanded the tubing just a little. An ordinary penknife was clamped into the toolpost of the lathe and by revolving the tubing and bringing the blade of the penknife against the under-side of the tubing, I found it possible to cut the rings off very accurately. When using this method, plenty of water should be applied to the cutting edge to prevent the knife from sticking and tearing the rubber. J. R. H.

LIMIT GAGE FOR MEASURING RECESSED WORK

The parts of a limit gage for measuring recessed work are shown in the accompanying illustration together with an assembled view of this tool and an illustration showing how it is used. The plug *A* enters the hole in the body of the gage *B* which has a dovetail slide machined in it to receive the two gage plates *C*. Pins *D* fit in the holes in the plates *C* and also extend through the elongated holes in the cover-plate *E*. In using this gage, the operator takes hold of the two pins *D* between his thumb and index finger and draws the sliding plates *C* back until the pins engage the inner ends of the elongated holes in the cover plate *E*. The plug *A* is then pushed into the hole and causes the sliding plates *C* to move out from the center. It will be seen that there are two shoulders above the pilot on the plug *A*. In order for the work to pass inspection, it will be possible for the first shoulder to enter the hole in the gage; but if the second shoulder can also be entered into the hole, it shows that the work is too large and results in its rejection. After gaging, the plug *A* is pulled out and the pins *D* drawn back so that the gage can be removed from the work.



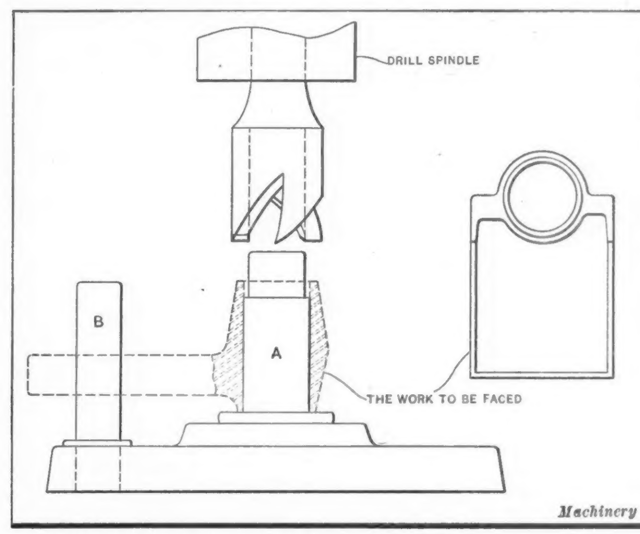
Parts and Assembled Gage and its Application in gaging a Recess

In making this tool, the plug *A* is hardened, ground and lapped to the required size. The body *B* is next made with the dovetail groove to receive the sliding plates *C* which are made in one piece to enable the hole to be lapped to size and the piece to be placed on a mandrel to grind the outer surfaces to the required diameter. Before hardening, the piece forming the two plates *C* is sawed almost through at the center from both sides, and after lapping the hole and grinding the outside, the piece is parted to form the two plates *C*. The cover plate *E* with elongated holes to receive the pins *D* has already been referred to. A gage of this type could be used to advantage in measuring a great variety of recessed work.

Dayton, Ohio. M. T. Byrne

IMPROVED METHOD OF FACING AND COUNTERBORING

The accompanying illustration shows a hollow mill for performing facing and counterboring operations, and a fixture in which the work to be machined is mounted on the stud *A*. The purpose of this equipment is to avoid trouble which arises when using the ordinary form of counterbore, owing to the tendency of the pilot to cut or bind in the hole. It will be seen that the stud *A* is provided with a pilot which enters the



Tool for facing and counterboring, which eliminates Trouble from Pilot cutting or binding in Hole

hollow mill and acts as a guide while the work is carried on the body of the stud. The pilot is made 0.0015 inch smaller than the hole in the mill and is hardened to give it the required durability. The body of the stud must be slightly shorter than the length to which it is required to finish the work.

The work to be faced is shown in the illustration and the dotted lines also show the position of the work on the stud *A*. It will be seen that the work swings around until it comes into contact with the stop stud *B* which prevents it from turning while the machining operation is performed. One end is faced off square, after which the work is turned over and faced on the opposite side, the second operation serving the double purpose of facing the work and bringing it to the required length. The stud *A* can either be mounted in a stand for use on the drill press or it may be provided with a tapered shank to enable it to be set up in the lathe tailstock. When used in the lathe, the cutter is mounted in the spindle and it may either be provided with a taper shank to fit directly in the spindle or held in a chuck. If the work to be machined has no overhanging part that can be engaged by a stop to prevent it from turning, a special holder is easily made. For example, in facing bushings of small diameters, the holder consists of an arm with a split collar which is clamped around the bushing by a wing nut. The arm comes into contact with the ways of the lathe or the tool-rest, and prevents the work from turning.

It will be evident that this form of tool will not replace the commercial counterbore for toolroom use, but it is certainly a most valuable tool for manufacturing operations. The combination is not only more durable, but a higher rate of production can be obtained by using it. The writer does not claim to be the originator of the idea but believes that it possesses sufficient merit to warrant bringing it to the attention of those readers of Machinery who are not already familiar with it.

Readville, Mass. O. A. Webster

MILLING FIXTURE WITH A KNOCK-OUT ATTACHMENT

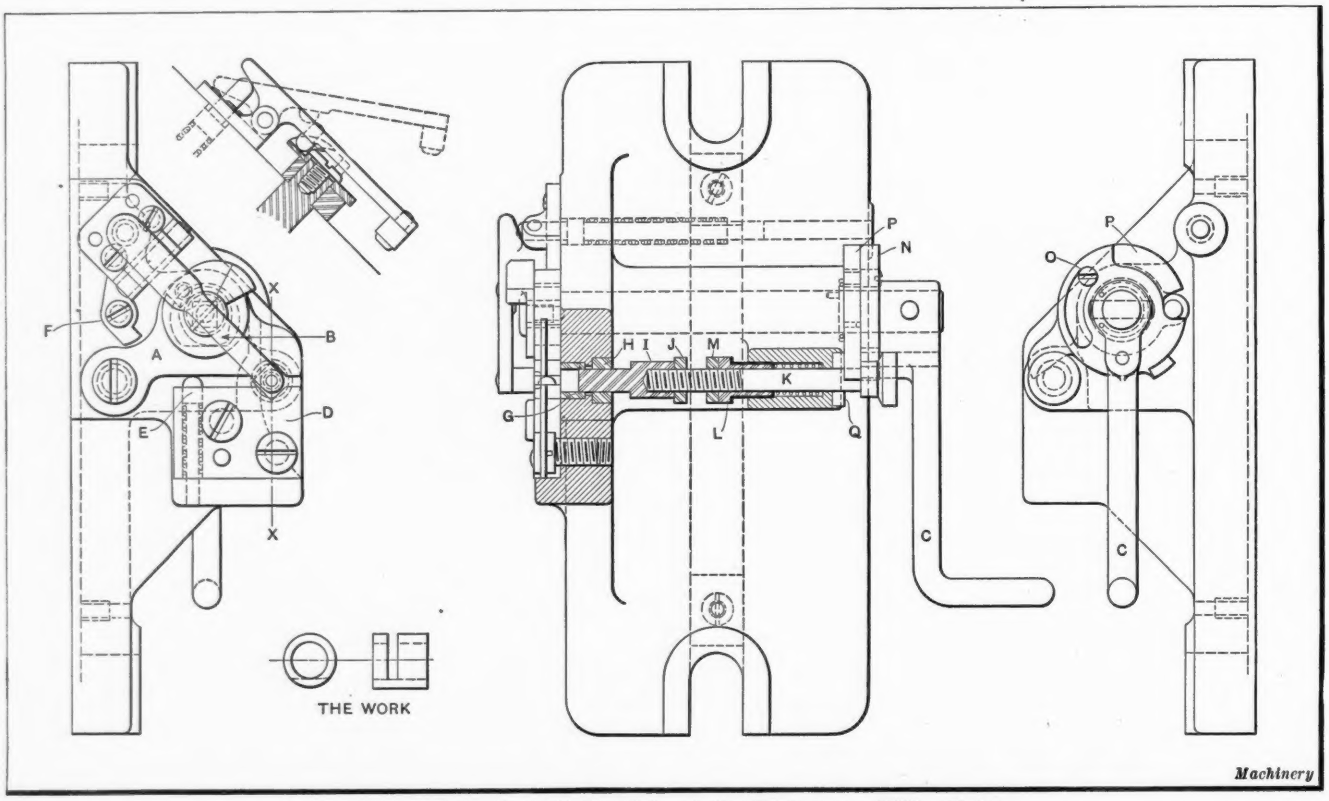
A milling operation usually heats the work to a point which makes it impossible—or at least unpleasant—to remove it from the fixture by hand; and in such cases it becomes necessary to use a tool for this purpose. Again, the work may be quite small and the fixture so constructed that the fingers cannot reach it, again making the use of some sort of tool necessary. A piece of wire may be satisfactory for this purpose but it takes time to manipulate it, and to pick it up and lay it down, when both hands are required for handling the work and operating the fixture or feed mechanism. In many cases the time consumed in taking the completed work out of the fixture is so great a part of the total time that it becomes imperative to provide for the automatic removal of the work. This is particularly true when automatic ejection may be easily and positively accomplished, as in the case of the fixture which forms the subject of this article.

This fixture was designed for milling the slot in the small machine steel collar shown in the illustration. The work is of such a size and shape that it cannot be removed from the fixture by hand, and as the operator required one hand to deliver blanks to the fixture while the other operated the gripping lever, the automatic removal of the finished pieces soon paid for the added cost of the fixture and eventually effected a material saving in the cost of production. The fixture is shown in position ready for the milling operat'on, the swinging jaw *A* being closed against the work by the cam *B* which is carried on a shaft operated by the lever *C*. The work is held against the fixed jaw *D* and centered by the V-grooves in the two jaws. To release the work, the lever *C* is raised, turning the shaft and cam, and thus relieving the pressure on the work and allowing the swinging jaw to be turned back by means of the spring plunger *E* until it strikes the adjustable stop *F*.

In the plan view, the top of the fixture is cut off along the line *XX* to show the knock-out mechanism in cross-section. Flush with the left-hand face of the cast-iron base there is a work-seat *G*, and next to it the anvil *H*, which is located against the shoulder in the base to prevent the knock-out mechanism from disturbing the work-seat. The hammer *I* is slightly larger than the hole in the work and has a shoulder which strikes the anvil after the end of the hammer strikes the work. The force of the blow may be reduced by loosening the lock-nut *J* and turning back the bolt *K* until the desired length of stroke has been obtained, after which the lock-nut is again tightened. The tension of the knock-out spring may be regulated by means of the threaded sleeve *L* and the lock-nut *M*, thus providing further adjustment of the blow. The knock-out is released by the upward movement of the lever *C*.

The disk *N* is fastened to the lever *C* and slotted to receive the stop-screw *O* which is fixed in a second disk *P*. As the lever is swung up, the disk *N* strikes the stop-screw which carries the disk *P* with it. The projecting arm on the disk *P* lies between the shoulder on the knock-out bolt and the steel plate *Q*. When this arm on the disk *P* is suddenly swung out of the way, the knock-out delivers a sharp blow of sufficient force to throw the work clear of the fixture, after which it drops into a pan placed to receive it. In this way the removal of the work does not take up any time, as the knock-out has delivered its blow when the gripping lever reaches the top of its swing, so that a new piece may be put in place and the lever once more swung down to clamp the piece in the fixture.

Bridgeport, Conn. F. W. BARROWS



Arrangement of Knockout Attachment for ejecting Work from a Milling Fixture

DRILLING SPEEDS

In a machine shop where jobbing and contract machine work are done, there are always a number of mechanics who have drilling to do but who possess little or no idea of the proper speeds to employ. In many cases it depends entirely upon the operator's judgment whether or not the machine is run at the highest speed that is consistent with good work. If the mechanic's judgment is poor—mere guesswork—a satisfactory rate of production combined with good work cannot be reasonably expected. When such a mechanic is given a table of drilling speeds expressed in revolutions per minute, it frequently happens that he does not know how to use it, and the average foreman does not have much time to explain details of this kind. A table of the form presented herewith represents a simple means of conveying the required information in regard to suitable drill speeds. Such a table can be made on tracing cloth so that blueprints may be made from time to time. These prints should be pasted on a piece of board and given a coat of shellac or varnish to keep them clean. They can be hung near the drilling machines for ready reference.

It will be seen that the diagram at the left of the table

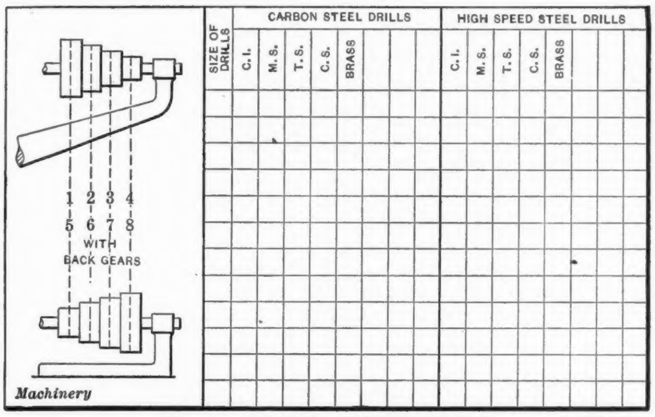
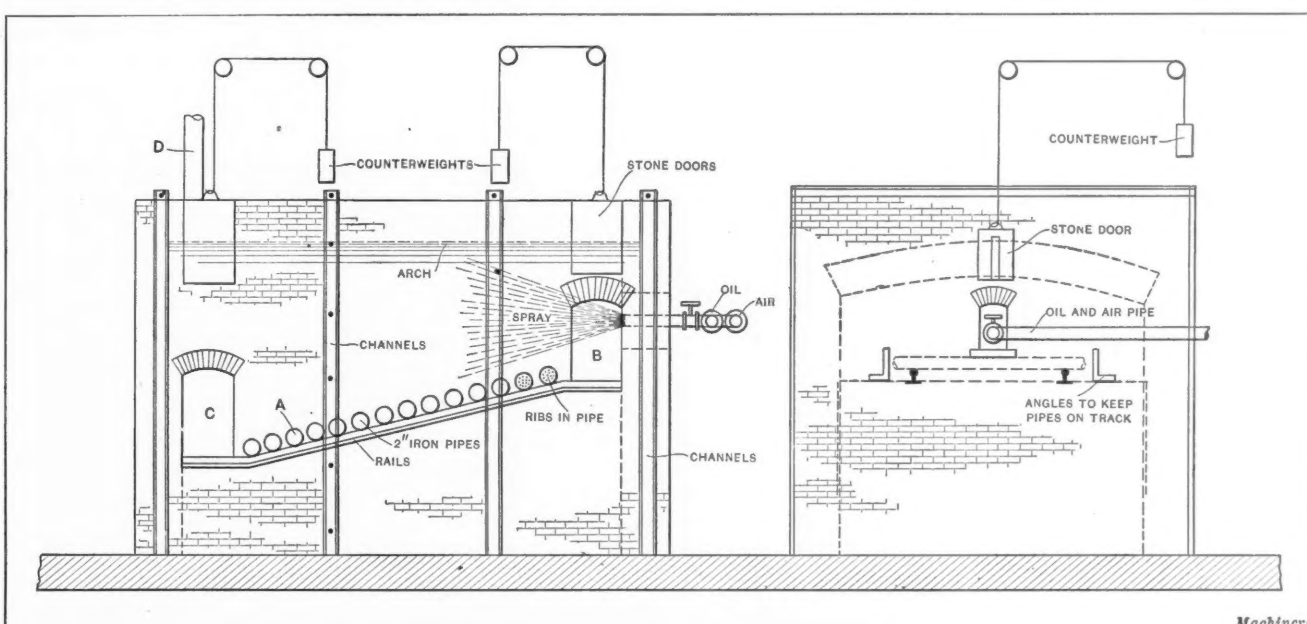


Diagram and Table of Drilling Speeds

shows the belt positions with and without the back-gears, these positions being numbered 1, 2, 3 and 4 for the direct drive, and 5, 6, 7 and 8 when the drive is through the back-gears. It will be obvious that each one of these belt positions corresponds to a certain number of revolutions per minute of the drill spindle. By calculation or from data taken from a machinists' handbook, the table at the right-hand side may be filled in with the numbers of the belt positions, giving the speeds nearest the correct ones. With this the mechanic only has to know the size and kind of drill he is using and material he is drilling, in order to determine the correct drilling speed to employ. The preceding information refers to the application of a table of this sort to drilling machines, but similar tables could be compiled for lathes, milling machines, boring mills and any other machines that make use of cone pulleys and back-gears to provide the necessary speed variations. The table could be made to include the proper feed to employ with each speed and material, but great care must be used or the entire object of the scheme will be lost. The average machinist has difficulty in using any but the simplest of tables, and his judgment in regard to the feeds is generally more accurate than his ideas of the correct cutting speeds. F. G. M.

FLUELESS HARDENING FURNACE

Some time ago I built an oil-heated furnace for use in hardening the ribs of umbrellas. As this has one or two unusual features in its construction and method of operation, it may prove of interest to some of MACHINERY'S readers. The umbrella ribs are inserted in pipes and placed in the furnace so that the pipes rest on two iron rails, as shown at *A*, which serve as a track. The pipes are charged into the furnace through the door *B* and withdrawn through the door *C*; in passing through the furnace in this way, the ribs contained in the pipes have been brought to the proper temperature for quenching.



Arrangement of Oil-heated Furnace for hardening Umbrella Ribs

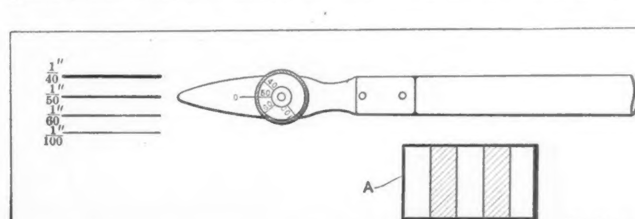
The oil for heating the furnace is sprayed into the combustion chamber with air at 30 pounds pressure. An interesting feature of the method of operation is that the furnace was originally used with a flue *D* but it was found that a large amount of heat was lost through the flue. In attempting to correct this loss of efficiency, we shut the flue off entirely and were surprised to find that very little trouble was experienced through the gases that were given off. After closing the flue in this way, the time required for bringing the work to the hardening temperature was practically cut in half.

Umbrella ribs are made of steel with various carbon contents and as a result, they must be quenched at different temperatures. Consequently, we still adhere to the color method for determining the proper quenching temperature. For example, carbon steel containing 1.20 per cent of carbon is brought to a white heat and then quenched in a tank of fish oil. This variation in the steel used makes it necessary for the man in charge of the hardening department to have had sufficient experience to judge the proper quenching temperature accurately. The ribs are made of carbon steel stock 1/32 by 1/4 inch in size, which is bent to the required form.

Westchester, N. Y. JOHN E. CAHILL

DRAWING LINES OF UNIFORM THICKNESS

In a certain drafting room where I was employed, all drawings had to be made with the different classes of lines kept to a uniform thickness, as shown in the accompanying illustration at *A*. To obtain this result, the draftsmen were in the habit of using a cut-and-try method; that is to say, they drew a number of lines on a piece of scratch paper, scaling each time and resetting the pen until a line of the desired thickness was obtained. This was necessarily a slow method and to avoid the loss of time in this way, I equipped my pen as shown in the accompanying illustration. An index or zero line was first scribed on the nib and then after adjusting the pen to draw the different thicknesses of lines required, lines were marked on the head of the thumb-screw



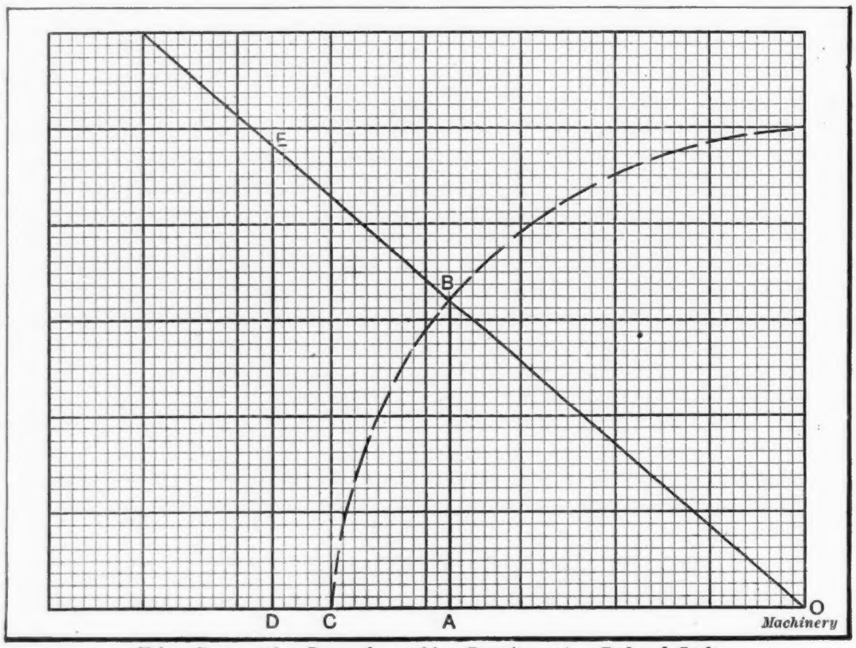
Draftsman's Pen arranged to enable it to be set quickly for drawing Lines of Various Thicknesses

to enable these settings to be obtained, a line being marked for each required thickness of line. This method proved so successful that all of the draftsmen adopted it.

Detroit, Mich. PAUL P. VLASEK

SUBSTITUTE FOR PROPORTIONAL DIVIDERS

The copying of a drawing to a reduced scale can readily be done without the use of proportional dividers. The device for doing this work is made from a piece of cross-section paper. First lay off any horizontal distance *OA*, and then find a radius *OC* so that the ratio of *OC* to *OA* is equal to the ratio of reduction required; with this radius strike an arc *CB* of indefinite length. Then at the point *A* erect a perpendicular intersecting the arc at *B*. Now draw a line through points *B* and *O*. This gives the means of making the reduction. To use the device, take off a distance on the large drawing with the dividers. Assume that this distance is equal to *OE*. Lay this off on the diagonal line, then the required distance reduced to scale will be found by dropping a perpendicular to *D*. This can be done with the aid of the vertical lines on the cross-section paper without any construction. *OD* is then the required distance. The basis for the method is the geometrical theorem that similar sides of similar triangles are proportional.

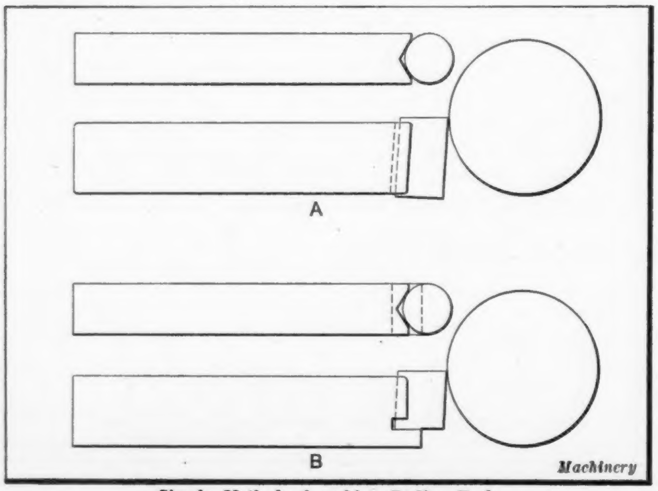


Using Cross-section Paper for making Drawings at a Reduced Scale

Owego, N. Y. SIDNEY K. EASTWOOD

SIMPLE RADIUS TOOLS

The making of a radius tool is a job on which some mechanics spend a great deal of unnecessary time, and to make such a tool by some of the methods in general use is indeed a tedious task. The following describes a way in which such tools can be made very quickly and still obtain the required degree of accuracy. Referring to the illustration, any piece of stock which can be conveniently held in the toolpost is shaped with a vee on one end as shown at *A*. Then a piece of steel is turned to the proper radius; drill rod of the required size can often be used. This piece of steel which forms the cutter is then hardened and sweated onto the holder.



Simple Method of making Radius Tool

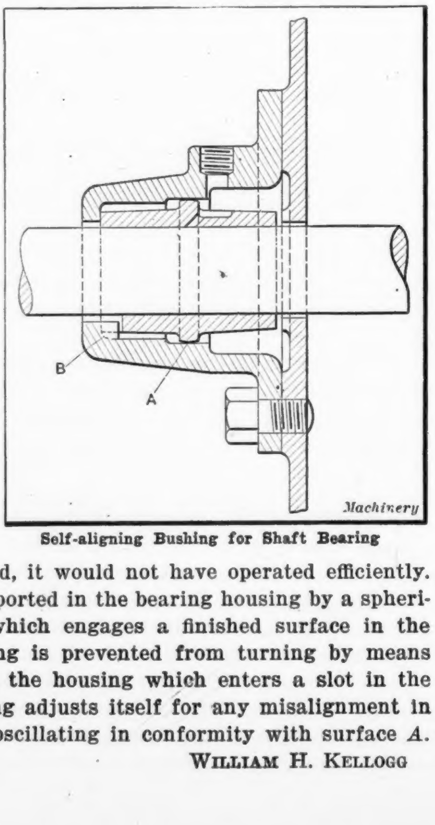
The best method of sweating is to tin both the cutter and the shank, after which they are placed together and a little heat applied with the soldering iron until they are joined firmly together. I have seen tools of this character made with cutters as small as 1/16 inch radius, and the temper of such small cutters was not injured in the least. If there is fear of drawing the temper, the cutter should be hardened but not drawn, heat from the sweating operation being relied upon to draw the temper to the required point. A further precaution to avoid drawing the temper of the cutter consists of merely tinning the holder and when this method is followed, it will usually be found that the two pieces will sweat together quite readily.

If the sweating is properly done, the tool will stand any ordinary thrust without damage. If, however, there is any fear of the union obtained in this way not being sufficiently strong, the tool may be made as shown at *B*. Here it will be seen that a vee is cut in the end of the shank, as in the preceding case, but that a shelf is left at the bottom of the vee to afford additional support for the cutter. Constructed in this way the cutter is supported by the shelf and there is no possibility of its breaking.

Hartford, Conn. S. VICTOR BROOK

SELF-ALIGNING BUSHING

I was interested in reading an article by Charles C. Anthony in the September number of MACHINERY, entitled "Cast Iron and Brass Bushings," and this reminded me of a special self-aligning bushing which I recently designed. The feature of this bushing is the provision which is made for allowing it to adjust itself automatically to the alignment of the shaft. This was made necessary by the fact that the bearing was used on a washing machine, the bearing housing usually being supported by a sheet metal tank which was so flexible that if some method of automatically regulating the alignment had not been provided, it would not have operated efficiently.



Self-aligning Bushing for Shaft Bearing

The bushing is supported in the bearing housing by a spherical faced flange *A* which engages a finished surface in the housing. The bushing is prevented from turning by means of a projection *B* on the housing which enters a slot in the bushing. The bushing adjusts itself for any misalignment in the shaft by simply oscillating in conformity with surface *A*.

Chicago, Ill. WILLIAM H. KELLOGG

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

COOLING OVERHEATED PHOSPHOR-BRONZE BEARINGS

J. A. W.—In a pamphlet published by a firm manufacturing gas engines, I found the statement that water should not be used to cool off a phosphor-bronze bearing that had become overheated, but no reason was given. Will you kindly tell me what the danger is?

A.—This caution is given by manufacturers for the reason that overheated phosphor-bronze will crack when suddenly cooled by dashing water over it. In case of overheating such bearings it is safest to let them cool down slowly.

PITCH DIAMETERS OF DRIVING AND DRIVEN CHAIN SPROCKETS

L. O. N.—Will you furnish data of the allowances made by makers of driving chain sprocket pitch diameters when the sprocket is the driver and when it is driven? I understand that the practice is to differentiate the pitch diameters of sprockets, making them slightly larger or smaller, depending on whether they are to be used as drivers or as driven wheels.

A.—The desired data is not available. Apparently, there is no agreement of practice. The Lehigh Car Wheel & Axle Works, Catasauqua, Pa., maker of face-hardened sprockets, informs us that it makes no difference between driving and driven sprockets.

MAKING JEWELERS' SAW BLADES

Q. C. T.—I would like to know how the teeth are cut in small jewelers' saw blades. These are made with varying numbers of teeth to the inch, some of which are extremely fine. The appearance of the saw under the magnifying glass would lead one to believe that the teeth were milled, but the blades are so extremely small and delicate that it would seem impossible to hold them for milling. In addition, the extremely low price at which they are sold, less than ten cents per dozen for most sizes, would indicate that some very quick method of manufacture must be employed. These saws are hardened full length and the temper color is plainly shown on the finished blade.

Suggestions from readers of methods for making these saws are requested.

BORING A SHAFT WITH A TREPAN DRILL

R. E. L.—In a nearby forge plant, 10-inch shafts 10 feet long are bored to a diameter of 8 inches, and in the process a core is cut out about 6 inches diameter and 10 feet long which is used for another shaft or other purposes. Can you furnish details of the tools used for this boring?

A.—The shaft is bored with a trepan drill or in other words a drill that cuts an annular groove leaving the center intact. It is virtually a pipe drill having cutting teeth on the end and fitted with lubricating tubes which furnish lubricant under heavy pressure for the purpose of cooling the cutting edges and forcing the chips out as fast as formed. Details of these tools would, no doubt, interest readers, and any one who can furnish same is invited to communicate.

COMPOUND INDEXING

W. W.—The following rule is given for computing the number of holes required for indexing by the compound method: Factor the number of divisions required; select two circles of holes at random on the same index plate for trial, and factor the difference; then draw a line under these two sets of factors. Now factor the number of revolutions required of the index crank to make one revolution of the index-head spindle, and place these factors under the line. Factor the number of holes in each circle chosen for trial and place these also under the line; then cancel similar factors above and below the line. If all factors above the line cancel, the division is possible with the two circles chosen. The product of the factors remaining below the line will be the number of holes to move forward in one of the circles, and backward in the other. *Example:* Divisions required, 154; circles chosen, 33 and 21; number of turns of crank on index head, 40. Factoring as mentioned, we have:

$$\begin{array}{r}
154 = 2 \times 7 \times 11 \\
33 - 21 = 2 \times 2 \times 3 \\
\hline
40 = 2 \times 2 \times 2 \times 5 \\
33 = 3 \times 11 \\
21 = 3 \times 7
\end{array}$$

After cancellation it will be found that the factors 3 and 5 will remain below the line; hence, $3 \times 5 = 15$ holes is the number that the index pin is moved forward in the 21-hole circle and backward in the 33-hole circle to get the required division. What is wanted is an algebraic solution or the mathematical reasoning which leads up to the cancellation shown. On what principle is this method founded?

A.—The method for finding the movements for compound indexing is based upon the principle that the difference between two moves obtainable on the index plate equals the required division. A certain number of holes moved forward in one circle and the same number of holes moved backward in another circle gives a movement which could not be obtained by any one index circle. To prove the method mathematically, proceed as follows: Let X be the number of holes sought. Other quantities are as in the given example. Now a movement of X number of holes forward in the 21-hole circle and X number of holes backward in the 31-hole circle equals $\frac{1}{154}$ of a revolution of the work, or:

$$\frac{X}{21 \times 40} - \frac{X}{33 \times 40} = \frac{1}{154}$$

$$\frac{X}{40}\left(\frac{1}{21} - \frac{1}{33}\right) = \frac{1}{154}$$

$$\frac{X}{40}\left(\frac{33 - 21}{21 \times 33}\right) = \frac{1}{154}$$

$$\frac{X}{40 \times 21 \times 33} = \frac{1}{154(33 - 21)}$$

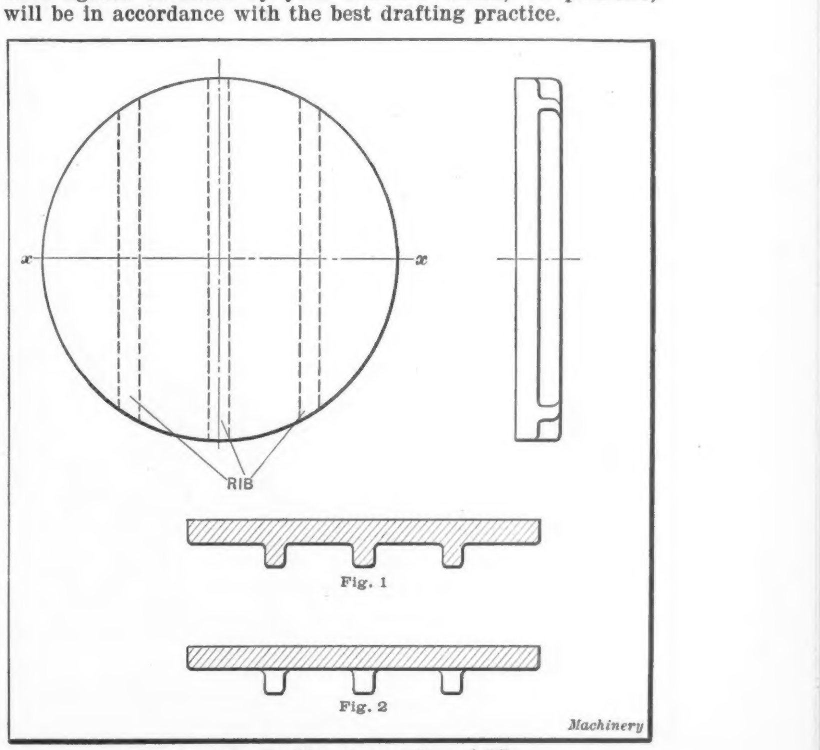
This shows that if the factors of 40, 21 and 33 are cancelled against the factors of 154 and $(33 - 21)$, the factors not cancelled in the denominator of the first member, when multiplied, will equal X.

In the given case, after cancellation:

$$\frac{X}{3 \times 5} = 1, \text{ or } X = 15.$$

DRAFTING CROSS-SECTIONS OF RIBS

W. A. D.—To settle a dispute among a few members of our drafting force, will you kindly inform me as to which is the correct method for cross-hatching the section x-x of the accompanying drawing. A claims that Fig. 1 is hatched, while B disputes this and claims Fig. 2 is correct. Both parties have agreed to abide by your decision which, we presume, will be in accordance with the best drafting practice.



Figs. 1 and 2. Drafting Cross-sections of Ribs

A.—According to practically universal drafting practice, the ribs should be cross-hatched as shown in Fig. 1. If the ribs lay beyond the plane x-x the drawing Fig. 2 would be correct, but it is not when the intersection plane passes through the ribs as in this case.

HOW SHOULD THE GRAIN RUN?

C. H. Mc C.—A question recently arose in our shops as to the proper way to order the material for certain tools which we use. These tools have blades shaped on the end like a twist drill, the blades being ½ by 2 by 2¼ inches in size, as shown in Fig. 1. We were in doubt as to the proper way to order the material; *i.e.*, with the grain running in the direction of the line *AA* or the line *BB*. We have been ordering

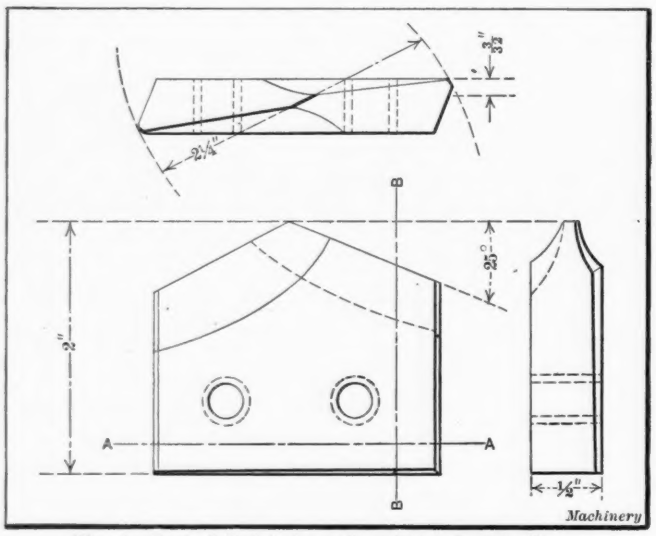


Fig. 1. Type of Tool to be made and Two Possible Ways for Grain to run

material ⅝ by 2⅜ inches in size, but I should like to know whether we ought to have ordered material ⅝ by 2⅛ inches in size. In the former case, the grain of the steel in the finished blade would run in the direction of the line *BB*, while in the latter case the grain runs in the direction *AA*. Any information on this point will be greatly appreciated.

Answered by A

In reply to question by "C. H. Mc C." in regard to the proper direction for the grain of the steel in tools of the type which he illustrates, there is no question in the writer's mind—although his opinion may be considered entirely theoretical—that the blanks for these tools should be cut off from the bar as shown at *C* in Fig. 2 rather than as shown at *D*. That is to say, the grain should run in the direction *AA*. When cut in this way, the grain of the steel in the tool is running crosswise—the grain of the steel in the bar naturally running lengthwise—and when the tool is in use there is a tendency to close up the grain of the steel instead of opening it up as would be the case if the blanks for the tools were cut off as shown at *D*. In this connection it may be of interest to know that flat forming tools for forming and relieving eccentrically relieved cutters would be distorted far more in hardening if the blanks were cut off from the bar as shown at *D* than would be the case if the blank were cut off as shown at *C*. This is a point of exceptional importance because in most cases such tools cannot be ground after hardening.

Another point of interest from a manufacturing standpoint is the way in which the blanks for the tools shown in Fig. 1 can be machined on the sides. The thickness of the stock need be only 1/16 inch over size and this would ordinarily be entirely inadequate, even on high-speed steel, owing to the decarbonization of the steel to a depth of at least 1/32 inch, which necessitates grinding away this amount of metal from the surface after the hardening operation has been performed. But as high-speed steel is very expensive it is possible to grind the pieces on a magnetic chuck, provision being made for tipping the chuck both lengthwise and crosswise, as shown in Fig. 2 at *E*. In this way the same result is obtained as would be possible if the thickness of stock used had been ⅛ inch over size. The saving of material effected in this way will be readily appreciated when the broad flat sides of the cutters are considered. The width of the stock used should be ⅛ inch over size, the amount of material removed on each side being shown at *C* in Fig. 2. In this way the benefit of having the point of the tool 3/32 inch below the outside of the bar from which it was cut can be obtained.

PRICES OF SECOND-HAND MACHINE TOOLS

A. L. F.—Can you give me some quotations of prices obtained for second-hand machine tools in good condition? If so, please quote a few.

A.—Prices of second-hand machine tools vary widely, depending on what "good condition" is interpreted to mean. Good condition to one prospective purchaser might be anything but good to another. It all depends on the point of view and the use to which the purchaser intends to put the machine. The following are some prices quoted on the equipment of a New York City concern manufacturing light machinery that was built in large lots to gages and micrometer measurements:

No. 0 Brown & Sharpe plain milling machine, overhanging arm, four-step cone, 6-inch by 20-inch table.	$125
Brown & Sharpe manufacturing type slab milling machine, overhanging arm, vise, three-step cone, 6-inch by 19-inch table	175
Brown & Sharpe manufacturing type slab miller, overhanging arm, vise, three-step cone, 6-inch by 30-inch table	225
Garvin plain milling machine, overhanging arm, four-step cone, 5-inch by 31-inch table	100
Pratt & Whitney Lincoln type slab milling machine, 30 inches between housings, 6-inch by 32-inch table	125
Hendey tool-room lathe, 12-inch by 5-foot, double friction countershaft, taper attachment, draw-in attachment, 9-inch four-jaw chuck	265
Bradford lathe, 14-inch by 6-foot, hollow spindle, compound rest, chuck	175
Pratt & Whitney lathe 16-inch by 9-foot, hollow spindle, compound rest, attachment	260
Mechanics Machine Co.'s 12-inch upright drilling machine	35
Dwight Slate single spindle sensitive drill	30
Prentice Bros. drilling machine, 20 inches swing, wheel and lever feed	50
Brown & Sharpe No. 1 full automatic screw machine, 5/16 inch capacity	100
Cleveland full automatic screw machine, 5/16 inch capacity	125
Warner & Swasey hand screw machine, 1 inch capacity.	125
National-Acme automatic screw machine, ¾ inch capacity, four spindles	650
Bliss No. 74½ straight sided geared press, 14 inches stroke	770
Farrel double-action toggle drawing press, 6 inches stroke drawing punch, 3¼ inches stroke blank holder, 19 inches between uprights	400

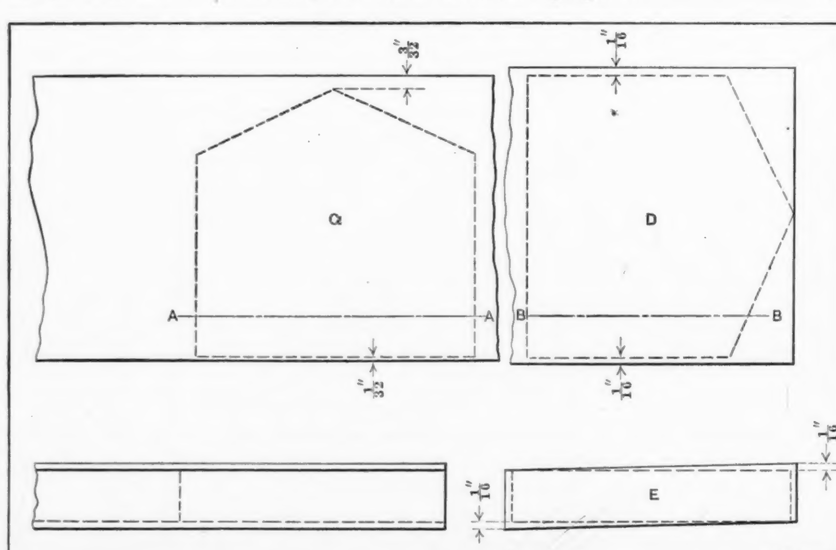


Fig. 2. Proper Way for Grain to run and Suggestion in regard to making Tools

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

MODERN GRINDING MACHINES

A complete line of these machines is being built, which comprises sizes ranging from a capacity of 24 to 60 inches between centers, with a swing up to 16 inches. The most noteworthy feature of the design is the arrangement of the gearing for obtaining the speed and feed changes, which is contained in a single gear-box. All gears are in mesh at all times, and the required gears are engaged with their shafts by a patented ball drive clutch. In this way an unusually compact construction is secured.

The Modern Tool Co., Erie, Pa., is now building a line of self-contained grinding machines equipped with individual motor drive or single pulley drive, as required. The design of these machines represents an exhaustive study of this particular class of equipment extending over a number of years; and the result is a heavy machine of rigid construction which is well adapted to withstand the class of service required of grinding machines of this type. Features exclusive to the grinding machines built by the Modern Tool Co. are included. This line of grinding machines comprises sizes ranging from a capacity of 24 to 60 inches between centers, with a swing up to 16 inches. Fig. 1 shows the front view

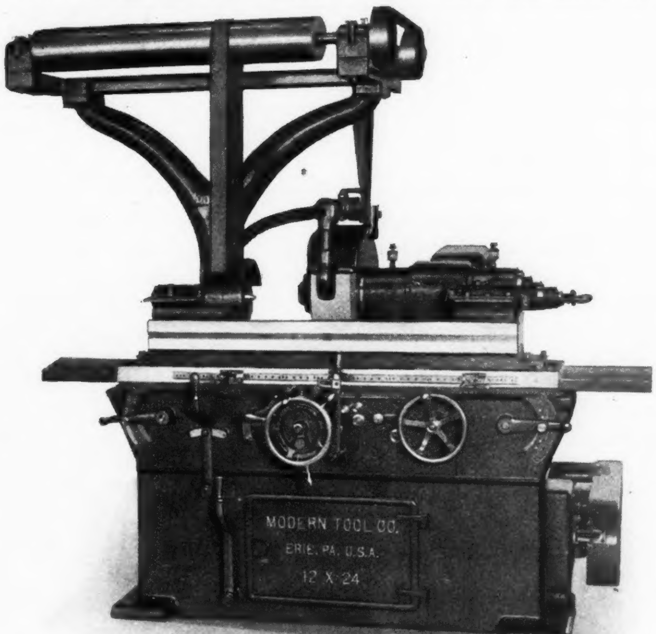


Fig. 1. Front View of "Modern" Grinding Machine

of the 12 by 24-inch plain grinding machine, and referring to this illustration it will be seen that all levers and handwheels are located where they are within easy reach of the operator. The economy of floor space resulting from the compactness of the construction and simplicity of the mechanism will be apparent from this illustration.

The table is provided with power traverse, which is controlled by means of a lever mounted at the left of the table handwheel, and when power is applied to the table the handwheel is disengaged and remains stationary. When the power traverse is disconnected from the table, the handwheel is simultaneously re-engaged for traversing the table by hand. The machines are equipped with automatic cross feed which can be set for a reduction of any amount from 0.0005 inch to 0.005 inch at either or both ends of the table reverse. This feature of feeding automatically on one end only is especially advantageous when grinding against a square shoulder. The feed is automatically thrown out when the work has been ground to size; a positive stop is provided for use when feeding the wheel by hand and when the production of duplicate work is required. An auxiliary feed can be supplied for

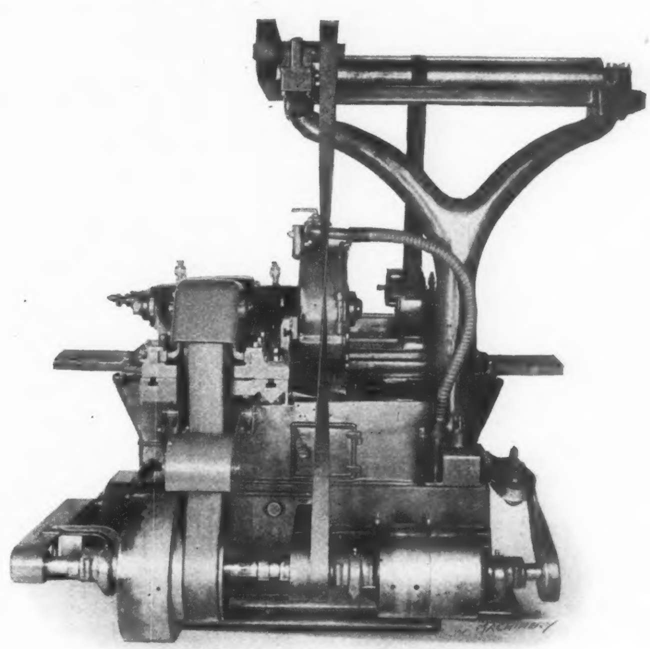


Fig. 2. Opposite Side of Machine shown in Fig. 1

bringing the wheel automatically into the work when the table is not being traversed, which is especially desirable when the work is short and can be covered by the full width of the wheel. The advantage of this feed is evident on this class of work, as it allows the operator to change the work dog while the machine is in operation, and the feed is automatically thrown out at any predetermined point. The cross feed handwheel has a collar which is graduated in 0.0005 inch spaces, and is in plain view of the operator. The automatic cross feed is adjusted by the movement of a lever to the point desired, as indicated on a graduated dial plate, and may be instantly changed to any feed while the machine is in operation. Another feature of note is the variable "tarrying device," by which the pause at each end of the stroke can be regulated.

The base of the machine is of massive proportions and has cross ties which insure absolute rigidity. V and flat guides are used throughout, such guides being used on the sliding table, swivel table and under the wheel stand. This insures a perfect alignment of all parts subject to the most wear. The base rests upon three points, preventing cross strain and insuring perfect alignment of the machine. These machines are provided with a powerful drive, and a large well proportioned spindle which runs in bearings of ample size. The wheel spindle is made of alloy steel, specially heat-treated, ground and lapped to the required size; it is

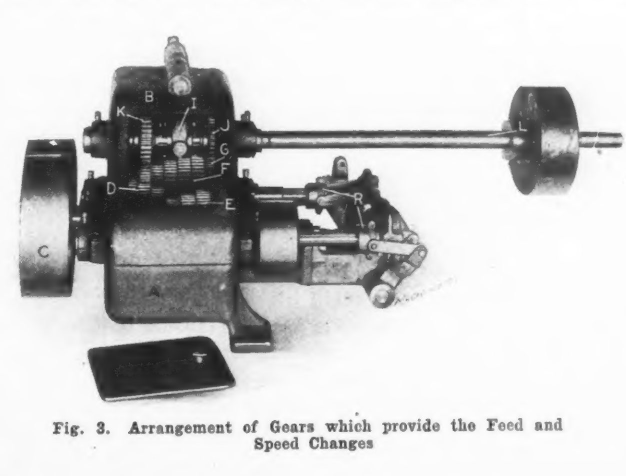


Fig. 3. Arrangement of Gears which provide the Feed and Speed Changes

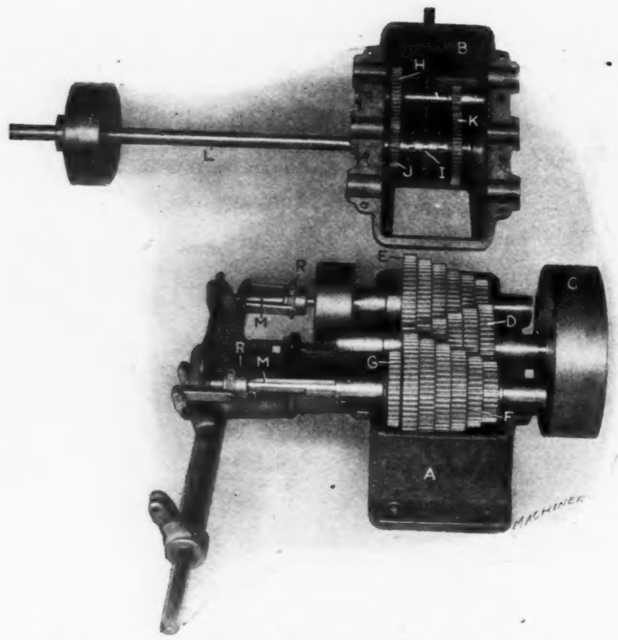


Fig. 4. Gear-box shown in Fig. 3 opened to show Arrangement more clearly

3¼ inches in diameter and runs in phosphor-bronze bearings 8¼ inches long. These bearings are the same length on each side of the driving pulley and are provided with sight-feed oilers which deliver a liberal supply of oil to the boxes at all times. The spindle is driven by a 6-inch belt which runs over large diameter pulleys, furnishing ample power to the grinding wheel. The wheel stand is of massive proportions, as may be seen by referring to Fig. 2. The wheel stand, which has a broad spread, slides on V and flat ways and is held down by gravity; but it is also provided with a safety gib to prevent lifting under abnormal conditions. The wheel center has a long, large bearing on the spindle, and will take any of the recognized standard grinding wheels. The regular wheel used is 18 by 2 inches in size, but wheels as large as 6 inches face and 24 inches in diameter may be used on the 12-inch machines; and wheels of 6 inches face by 30 inches in diameter may be used on the 16-inch machines, as special requirements demand.

The headstock is entirely belt driven, which gives an absolutely smooth movement to the work and eliminates all chance for chatter. It is fitted to the swivel table by means of V and flat ways, and is held in position by a hooked clamp bolt. The headstock spindle is hardened and ground and runs in bronze bearings adjustable for wear, being lubricated by means of a sight-feed oiler. The footstock is fitted to the swivel table in the same manner as the headstock, and the footstock spindle is held in any position by a spring, or it may be set positively against the work and locked. The work centers on the headstock and footstock are directly over and between the guides of the table, a construction which eliminates the weight and strain necessarily present where the work centers are outside and overhang their bearings. The wheel truing device is mounted on the footstock and is adjustable for all diameters within the range of the machine, so that the wheel can be trued up without removing the work from the centers. The steadyrests furnished with these machines are universal in all their movements. These are equipped with positive stops for grinding duplicate parts, have a very wide range, and are capable of delicate adjustment.

These self-contained machines have twelve work speeds ranging from 12 to 250 R. P. M., and six table feeds from 22 to 104 inches per minute, which cover every range within the capacity of the machines. The work speeds and table feeds are entirely independent of each other, making it possible to obtain a correct table feed for any work speed. All the speeds and feeds are controlled by levers on the front of the machine, and are derived from one gear-box, which is an entirely separate unit. All gears are in mesh at all times and are engaged with the shaft by a patented ball-drive clutch which effects a quick and safe change that can be made instantly while the machine is running at any speed. This gear-box, in addition to occupying a very small space, is so located as to be easily and readily inspected. While the operating mechanism of the gear-box represents a departure from established practice in designing grinding machines, it is not an experiment. It was designed a number of years ago by Mr. C. N. Payne, and has been in successful operation for several years in the Modern Tool Co.'s factory. In this time it has been thoroughly tested out, not only as an individual unit, but also in combination with the grinding machines.

The arrangement of gears by which the speed and feed changes are obtained is shown in Fig. 3. The gears are enclosed in a case and run in oil, the case being located on the base of the machine. The gear-box proper consists of two parts, the lower one *A* forming an oil-tight container for the lubricant and serving as the support for the three shafts. The upper part *B* carries the two shafts and gears for doubling the work speeds. The power is supplied from the main driving shaft on the back of the machine by belt to pulley *C*. The change speed device consists of three series of gears shown at *D*, *E* and *F* in Fig. 4. These gears are journaled in a case composed of the parts *A* and *B*, Fig. 1, and are at all times in mesh and run at constant speed. The center series of gears *D* are the drivers, and on the end of the shaft is the driving pulley *C*. The series of gears *E* controls the table feeds, and the series *F* controls the work speeds. The gear *G* meshes with gear *H* shown in the top of the case. The positive jaw clutch *I* engages the gear *J*, giving six changes of work speeds, and six additional changes of speeds are obtained by clutch *I* engaging the gear *K*. Clutch *I* is keyed to the shaft *L*, and on this shaft the gears *J* and *K* are mounted loosely.

A more detailed view of the construction of the ball drive clutch, which operates the table feeds and work speeds, is shown in Fig. 5. The series of gears *E* and *F* are made with hardened ball pockets, and are brought into positive action and locked individually with the (driven) shaft *M* by the ball *N* being forced into the ball pocket *O* in the hub of any gear by the flat cam *P* operated through the (driven) shaft *M*. The ball openings *Q* in the shaft are contracted at their inner ends, and the balls are larger than the contracted ends of the openings, so as to be retained in the openings and be in position to permit the turning of the gear on the shaft when the balls are in contact with the contracted ends and the cam has forced any one of the other balls into engagement with a gear. In Fig. 5, the flat cam *P* is shown attached to its shifting ring and yoke *R*.

"Modern" self-contained grinding machines have a single constant speed drive, which reduces the cost when equipping the machines with motors. The main drive is in the rear of the machine and runs at constant speed. Power is applied either from the lineshaft as shown in Fig. 1, by a single belt, or by direct motor connection.

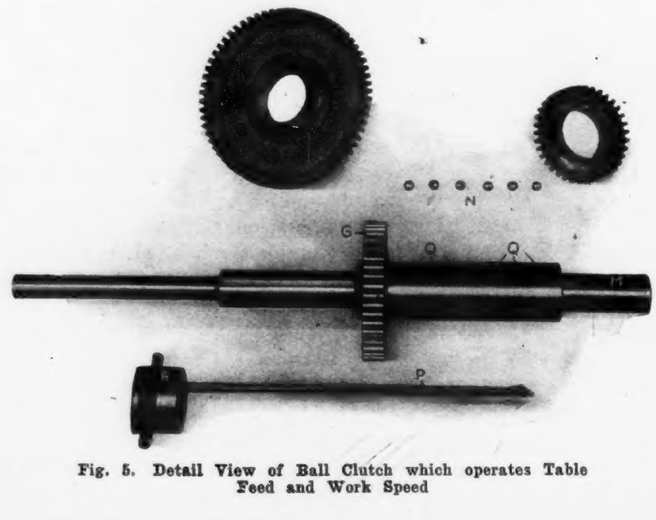


Fig. 5. Detail View of Ball Clutch which operates Table Feed and Work Speed

WALKER ROTARY DISK AND SURFACE GRINDER

Increased production and greater accuracy are secured through the provision of an accelerated speed and feed mechanism on this machine. The work speed is accelerated as the wheel approaches the center; and the horizontal feed of the wheel is correspondingly increased to maintain a constant rate of 3/8 inch per revolution of the work. The speed and feed are correspondingly retarded as the wheel recedes from the center. Specially constructed bearings prevent overhang of the ram occurring at any point of the stroke.

The noteworthy features of the rotary disk and surface grinder which has been added to the line of the Walker Grinder Co., Worcester, Mass., are the provision of an accelerated speed mechanism, by means of which the speed of the work and also the feed automatically accelerates as the wheel approaches the center of the work, or is retarded as the wheel recedes from the center; and the fact that the ways for the wheel-slide or ram are extended out from the frame of the machine in such a way that the ram never overhangs its bearings. The variable speed feature is obtained through an Evans cone located inside the frame of the machine.

The grinding wheel slide or ram is provided with V-bearings of ample size, which are oiled automatically by rollers in oil wells in the bearings. The under side of the ram is furnished with projections to which the grinding spindle bearings are bolted in a suspended position. These bearings are lined with hard bronze bushings which are adjustable, and lubrication is by means of the ring oiling system. The spindle pulley is made in the form of a drum of sufficient length to provide for the full stroke of the ram, this pulley or drum carrying a belt which runs over the driving pulley on the main shaft of the machine. The grinding wheel is held on the tapered end of the spindle by the well-known Walker system of internal tapered iron center with an inserted nut at the end; and the wheel may be mounted or removed from the spindle without requiring the use of a wrench. While this is being done the spindle is firmly held by means of a pin or spanner. The end thrust of the spindle is taken by a collar which is held against the shoulder of the spindle by means of a cap nut provided with a hardened steel button. On the main driving shaft *A*, Fig. 3, on which the pulley *B* which drives the wheel-spindle is mounted, there are also the pulley *C* which drives the variable speed mechanism, and a pulley for driving the water pump. It will be seen that the tight and

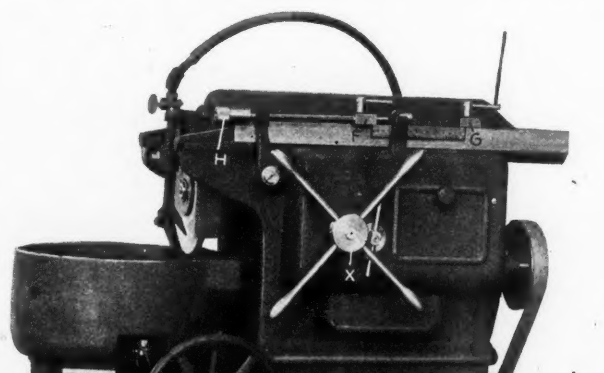


Fig. 1. Walker Rotary Disk and Surface Grinder

Fig. 2. View of Magnetic Chuck, Wheel, etc., of Machine shown in Fig. 1

loose pulleys are mounted at the end of this shaft and attention is called to the way in which these pulleys are completely enclosed except for the necessary belt opening. This opening is further protected by means of the curved shipper slide *D*, which is held down by a cap-screw and spring *E* to prevent it from rattling. This belt shipper is operated by the foot treadle shown at the front of the machine in Fig. 1. It will be evident from the preceding description that the machine is completely self-contained.

There is no particular novelty in the design of the reversing mechanism which consists essentially of the well-known arrangement of bevel gears with a positive load and fire type of clutch between them. The reversal is obtained by a pivoted lever which is operated by the dogs *F* and *G* on the ram, as shown in Fig. 1. Referring to this illustration, it will be noticed that a scale is provided which is laid out in "hole diameters" and "disk diameters," so that one dog is set to reverse the ram when the wheel reaches the hole at the center of the disk, while the other dog is set to reverse the ram when the wheel has reached the periphery of the work. The machine is provided with an automatic stop device which can be brought into operation after the wheel has passed beyond the work. It is brought into action by a slight movement of the knurled sleeve *H* which comes into contact with the upper end of a bellcrank lever at the end of the stroke, thus operating a suitable train of mechanism to stop the clutch in the neutral position, with the result that the ram is brought to rest. The work-spindle clutch is then thrown out of engagement by means of the lever *I*, Fig. 1, which is located in a convenient position for the operator. The machine is now at rest and the finished piece can be removed from the magnetic chuck and a fresh blank substituted in its place. After this has been done, the lever *I* is thrown back to the operating position to start the work in motion, after which the sleeve *H* is pulled back and the clutch is then automatically thrown into engagement by the action of a spring plunger. An instantaneous hand stop is also provided, the design of which is of a standard form.

The work-spindle is not subjected to any side thrust, and so it is practical to have this spindle journaled in split babbitted boxes. The spindle is supported on a hardened steel button *J* held in a solid cup *K* which is kept filled with oil, the arrangement being shown in Fig. 3. The knee is mounted on a vertical slide and pivoted on the sleeve *L*. The horizontal elevating shaft passes through this sleeve and delivers power to the vertical feed-screw *M* by means of bevel gears, the thrust of this vertical feed-screw being carried by a ball bear-

ing. Referring now to Fig. 4, we are in a position to give a detailed description of the mechanism provided for tilting the knee of the machine for grinding concave or convex surfaces as may be required; or for locating the knee in position for grinding flat surfaces. This is accomplished by means of the adjusting screw *N*, which enters a tapped hole through a boss on the lower part of the knee, the screw being held by a check-nut as shown. The operation of this device will be obvious to any mechanic, the principal feature of this tilting knee being the method adopted for quickly setting it back into position for grinding a flat surface after it has been set over for grinding concave or convex work. This result is obtained by means of the hardened steel screw *O* and the button *P*, the screw *O* being permanently set to adjust the machine for grinding flat work when this screw is in contact with the button *P*. In case of wear, the screw *O* can be adjusted. When it is desired to grind a concave surface it is merely necessary to loosen the check-nut and turn down screw *N* until the required angularity has been obtained, as indicated by the scale *Q*. When it is desired to grind a convex surface, it is necessary to swing the hardened steel button *P* to one side by means of the small handle in this button, the result being that the screw *O* is allowed to swing nearer

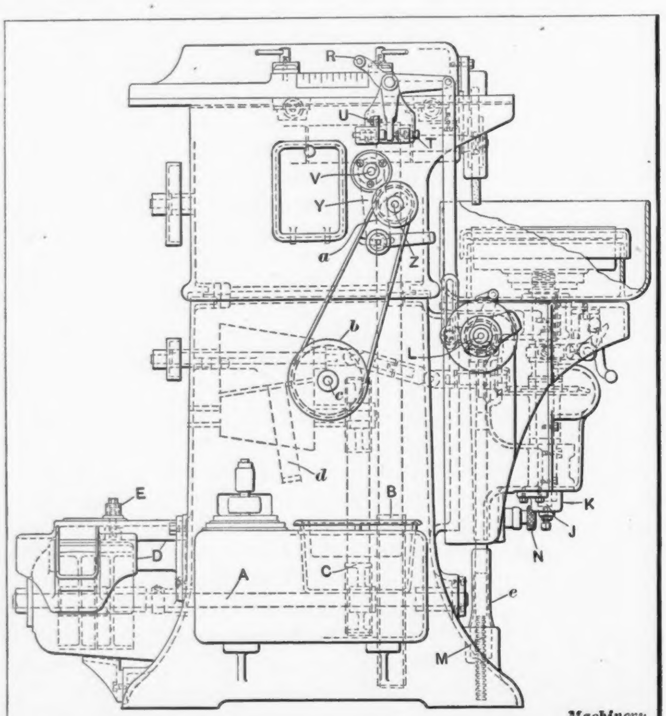


Fig. 3. Complete Side Elevation of Left-hand Side of Walker Grinder

the vertical slide when the adjusting screw *N* is loosened. In this way the proper angularity for the convex surface is obtained. When it is required to set the machine back for grinding a flat surface, it is merely necessary to swing the button *P* back into position and bring the screw *O* into contact with it.

The arrangement of the automatic vertical feed is shown in Fig. 5. This mechanism is located on the opposite side of the machine from the longitudinal feed mechanism, and is also operated by dogs mounted on the edge of the ram. These dogs run under the roller *R*, thus transmitting motion down to the ratchet and pawl *S* which operate the vertical feed. The dogs are faced with hardened steel wedges to prevent them from wearing, and the usual form of shoe is provided on the ratchet wheel *S*, this shoe being set to lift the pawl out of engagement with the teeth when the work has been ground to a predetermined thickness. It will be seen that the lower end of the rocker arm on which the roller *R* is mounted swings between a spring plunger on one side and a knurled screw *T* on the other. The screw *T* has a cylindrical graduated head which enters a recess, and a knurled check-nut is also provided for binding the screw in place. When the rocker arm is in contact with the set-screw *U* and the knurled headed screw *T* is tightened down onto the rocker arm, the roller *R* clears the dogs, with the result that there is no feed movement. By backing off the knurled headed screw *T* one graduation on its cylindrical head, a feed motion corresponding to one tooth on the ratchet *S* is secured; backing off two graduations results in picking two teeth on the ratchet wheel, etc. Each ratchet tooth corresponds to a feed of 0.0005 inch. It will be noted that the automatic feed can be operated at both ends of the stroke of the ram, that it is positive in action and that the function of the spring plunger at the lower end of the rocker arm which carries the roller *R*, is merely to draw back the feed pawl on the ratchet *S*.

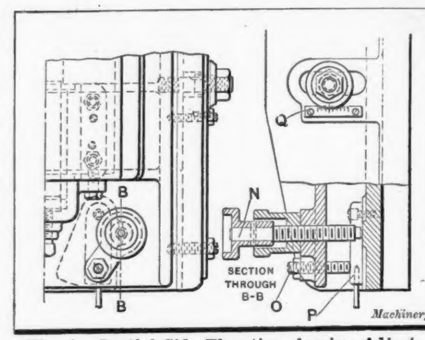


Fig. 4. Partial Side Elevation showing Adjustment for grinding Concave and Convex Work

The ram is driven by a train of feed-gears, the last of which is mounted on the pinion shaft *V*; and this pinion meshes with the rack *W* on the ram. The pilot wheel on the opposite side of the machine—shown at *X* in Fig. 1—is attached directly to the shaft *V* which has a transverse motion equal to a little more than the width of the feed-gears. The result is that when the pilot wheel *X* is pushed over, it slides the shaft *V* along and throws the automatic feed-gears out of mesh, so that the ram can be operated by hand. Around the pinion shaft *V* at its outer end there is a swinging arm *Y* which is provided with a boss and bearing for the shaft *Z*, on one end of which there is mounted a flanged pulley *a*, Fig. 3, the shaft *Z* carrying a gear which engages with a gear carried on the pinion shaft *V*. The lower end of the arm *Y* is provided with a stud which extends through a slot in the column of the machine, and a pull lever is attached to this stud to provide for setting the arm *Y* in any required position. The arm is then clamped in place by means of a nut on the stud. Both the rack pinion and the gear on the shaft *V* which meshes with the gear on shaft *Z* are of double width so that these gears are always in mesh regardless of whether the shaft *V* is in position to give power or hand feed to the ram. The flanged pulley *a* is connected by a belt to pulley *b* which is carried by a short shaft *c* journaled in a box mounted on the column of the machine. On the inner end of the shaft *c* there is provided a suitable mechanism for moving the friction belt *d* between the variable speed cones which are shown dotted in Fig. 3. It will be noted that the movement or location of the friction belt *d* is entirely controlled by the position of the ram, and that should the pinion on shaft *V*

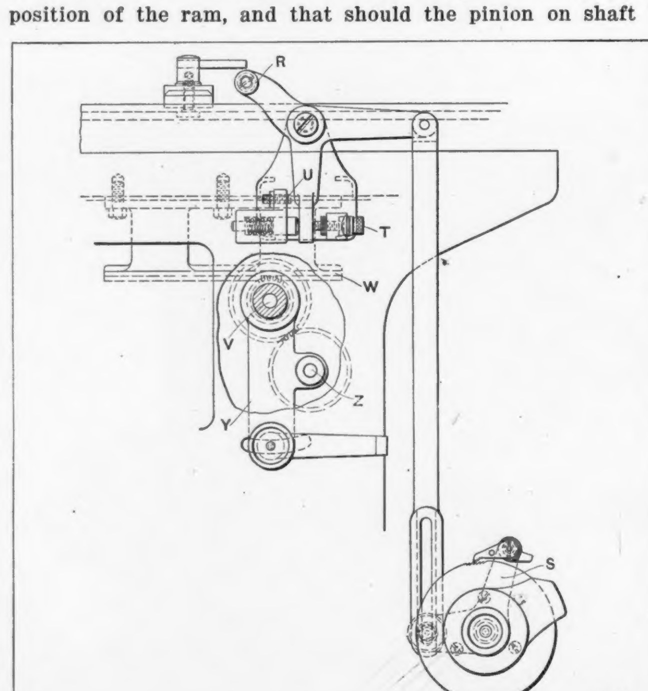


Fig. 5. Detail of Vertical Feed Mechanism and Connection with Variable Speed Device

be thrown into mesh with the automatic feed-gears, out of synchronism with the speed changing cones and the ram, the proper timing would be automatically adjusted at the end of the stroke. This is accomplished by the slippage of the belt running over the pulleys *a* and *b*, which happens in case the friction belt *d* on the variable speed cones reaches the limit of its movement prematurely. It will also be noticed that when using the hand feed, the belt running over the pulleys *a* and *b* can be slackened by simply loosening the nut on the stud carried by the arm *Y*, in this way disconnecting the variable speed mechanism. The connection from the Evans cone to the work spindle is through the universal jointed rod; the connection to the horizontal feed has been described.

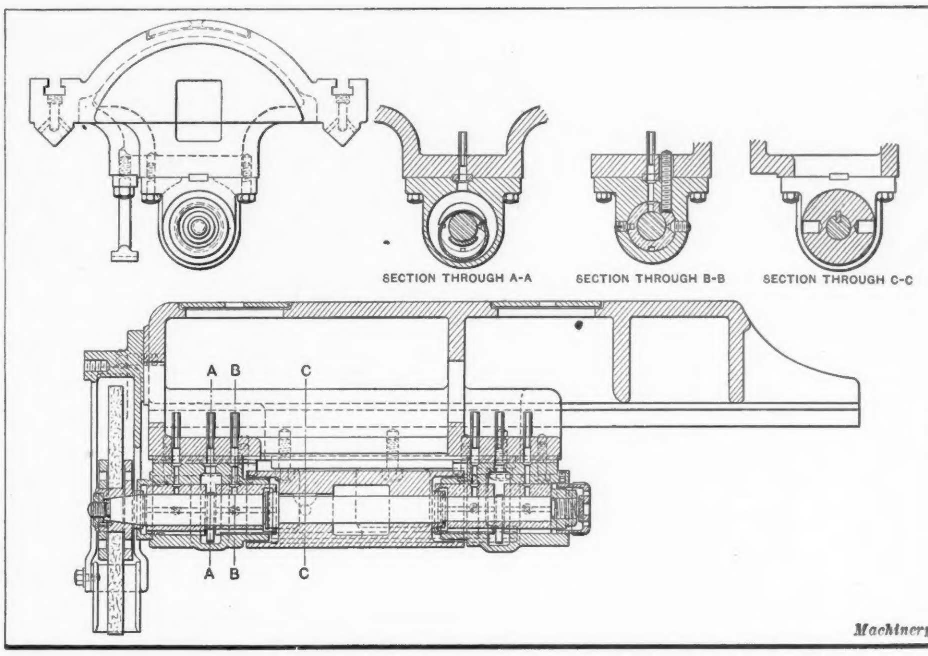


Fig. 6. Detail of Ram and Cross-sectional Views of Spindle Bearings

The mechanism for maintaining the proper work speed for all positions of the wheel, and a uniform horizontal feed of the wheel per revolution of the work, is the means of securing better results in both the finish and accuracy of the work. The horizontal feed of the wheel is at the rate of 3/16 inch per revolution of the work, the rate of feed being accelerated in exact proportion to the increase of work speed as the wheel approaches the center of the work; and the feed is retarded in the same manner as the wheel recedes from the center. If the feed were not accelerated to correspond with the increased speed of the work there would be no gain in production; and if neither the speed nor the horizontal feed were accelerated as the wheel approached the center of the work, the wheel would follow a spiral path of uniform pitch, as in the case of machines of this type which are not equipped with the variable speed and feed mechanism. Having less work to do as it approaches the center of the disk, as well as a proportionally greater time to do it, the tendency would be for the wheel to cut deeper at the center of the disk, thus causing the work to be finished with a slightly concave surface.

The water pump is of the usual form, and the design and construction of the lower part of the machine requires no special explanation, with the exception of calling attention to the guard *e* which fits loosely around the outside of the elevating screw for the knee, thus protecting the screw from grit. Attention has already been called to the safeguard over the tight and loose pulleys. Guards are also provided which cover the extensions of the V-bearings for the ram, so that danger of damaging these bearings with grit is eliminated. The machine is equipped with a Walker magnetic chuck which can be furnished in various sizes from 8 to 12 inches in diameter. The pump supplies a liberal amount of water for cooling the work. The machine takes grinding wheels 10 by ⅝ by 1¾ inch in size with a feed of fully 3/16 inch per revolution of the work. When feeding toward the center, the speed of the work increases 100 per cent in 5 inches travel of the ram, and grinds over a surface of 400 square inches per minute. The floor space occupied is 3 by 5 feet, and the net weight of the machine equipped with a 12-inch chuck is about 2000 pounds.

CLEVELAND MODEL G AUTOMATIC SCREW MACHINE

This machine is made in two sizes, one of which has a spindle capacity of 3/8 inch and a milling stroke of 3 1/2 inches; the other has a spindle capacity of 5/8 inch and a milling stroke of 4 1/2 inches. Work can be done in one operation on this machine which ordinarily requires two operations to finish it. Simultaneously with the working of the regular turret and cross-slide tools, work is done on the cut-off end, which is ordinarily performed by a second operation.

To meet the demand from manufacturers requiring a high-speed automatic screw machine particularly adapted for long runs on small work, the Cleveland Automatic Machine Co., Cleveland, Ohio, has added to its line the Model G machine which is illustrated and described herewith. This is made in two sizes, one of which has a ⅜-inch spindle capacity and a milling stroke of 3½ inches, while the other has a ⅝-inch spindle capacity with a milling stroke of 4½ inches. On many classes of work it is desirable to have a larger spindle capacity, and to meet this requirement the ⅜-inch machines can be furnished with an actual spindle capacity of ½ inch, while the ⅝-inch machines can be provided with actual spindle capacities of ¾ inch or ⅞ inch, the length of the milling stroke in both cases being standard. The spindles run at very high speed to give the proper cutting speed for any size of bar within the capacity of the machines. Fig. 4

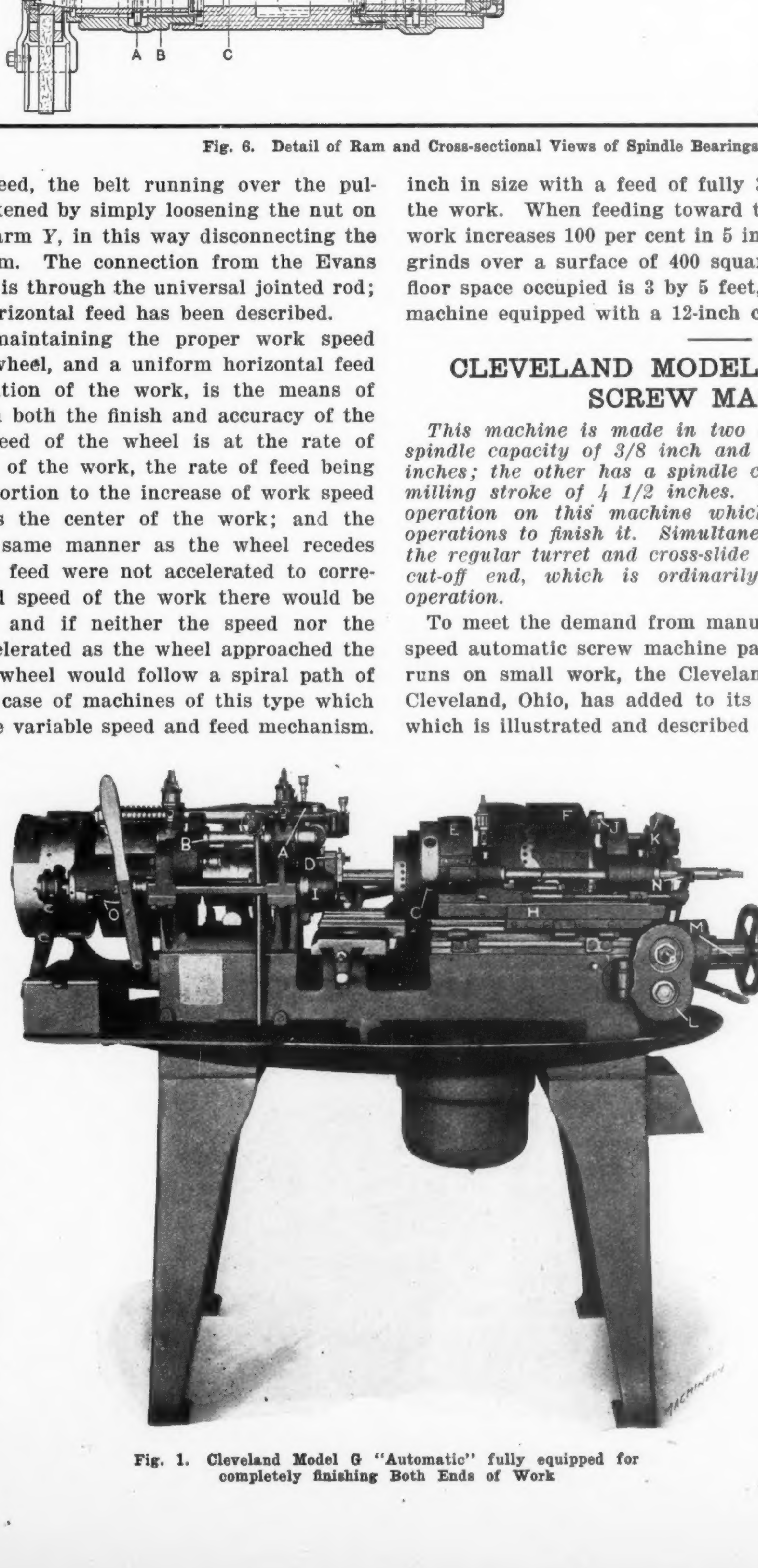


Fig. 1. Cleveland Model G "Automatic" fully equipped for completely finishing Both Ends of Work

and the accompanying table show typical classes of work for which this machine is adapted, and the rate of production which can be attained in manufacturing these parts from brass or steel.

The machine is designed to handle a great variety of work and is capable of completely finishing the parts which it produces. It performs in one operation what is almost universally done in two, and without any additional time being required. Simultaneously with the working of the regular turret and cross-slide tools, what is ordinarily a second operation is performed on the cut-off end of the work. In addition to the slotting or slabbing operation, which can be done on either or both ends, the cut-off end of the work may be shaved, counterbored, drilled, reamed or chamfered, thus completely finishing the piece ready for use. The finished work is ejected into a compartment separate from the chips.

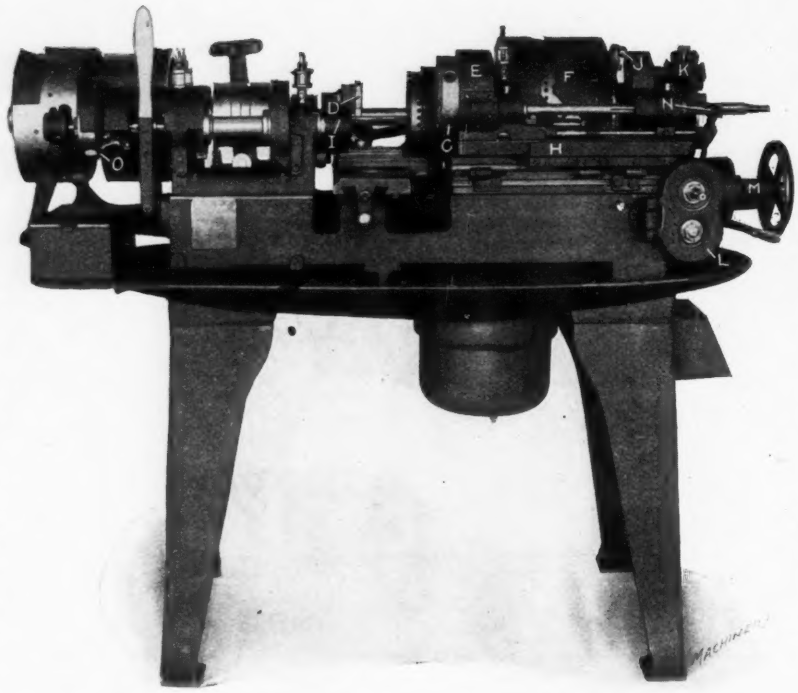


Fig. 2. Machine shown in Fig. 1 without Slotting Attachment and Secondary Spindle for performing Operations on Cut-off End of Work

The simplicity of the design and accessibility of all parts of Cleveland "automatics" are well known throughout the manufacturing world; for this reason they are particularly easy to operate, and the new Model G machine is no exception to this rule. The machine is constructed on similar lines to the regular plain machine of this company's manufacture, all movements being controlled by direct acting cams which are of the drum type, and extremely simple to make. A standard set of cams is furnished with each machine, by means of which any job within the capacity of the machine may be produced; and cams of various shapes may be quickly made for a variety of work. Figs. 1, 2 and 3 show the different combinations of attachments which are available. Fig. 1 shows the full attachment machine which is capable of completely finishing both ends of the work, as previously described. Fig. 2 illustrates the same machine without the slotting attachment and without the secondary spindle for performing operations on the cut-off end of the work. Fig. 3 shows the machine with the turret mechanism removed, which can be done in a few minutes, thus converting it into a most serviceable machine for plain work, with a milling capacity of 5½ inches long for the ⅜-inch machine, and 10 inches long for the ⅝-inch machine.

In Fig. 1, *A* is the slotting attachment, and *B* the shaving attachment carrying a secondary revolving spindle for finishing the cut-off end of the work. This spindle is driven by a belt direct from the countershaft on the ⅜-inch machine, and by gears from the main spindle on the ⅝-inch machine. The work is carried to the slotting and shaving attachments by a conveyor held in the turret *C*, this conveyor being fitted with a spring collet which grips the work just as it is separated from the bar. The shaving, counterboring, drilling, reaming or chamfering on the cut-off end of the work is performed during the time the regular turret and cross-slide tools are doing their work, so that the piece is finished all over in the same length of time that would ordinarily be consumed in the first operation. Double cross-slides are provided, the front and rear slides having independent control. Forming tools may be carried on each of these slides and both tools may operate at the same time or independently as desired, the cutting off being accomplished by means of a tool held in arm *D* which swings down from above and cuts off the work. This independent cut-off attachment in no way interferes with any of the other tools either on the cross-slide or in the turret.

The turret head *E* is carried on a longitudinal slide which receives its motion from the hardened steel cams on the drum *F*. There is a cam for each turret tool and the stroke of the turret may vary to suit the length of cut required by each tool. In Fig. 3 *G* is the bracket carrying a roll upon which the tool feed cams operate. This bracket is adjustable along the top of the slide *H* to any position, and the turret may thus be adjusted close to or away from the chuck hood *I* to suit short or long work. The indexing of the turret from one hole to the next consumes but 1/5 second and is entirely independent of the longitudinal position of the turret. This is accomplished by means of five cams *J* mounted on the end of the turret cam drum *F*, which may be adjusted to any position around the drum. Any number of holes may be skipped when not needed, thereby saving the time ordinarily consumed by the idle stroke of the turret, and all movements of the turret are under such complete control on account of the adjustments described that the idle movement is negligible. The feed and idle movement of the machine are controlled by cams *K* which are adjustable to any position around the periphery of the disk upon which they are mounted.

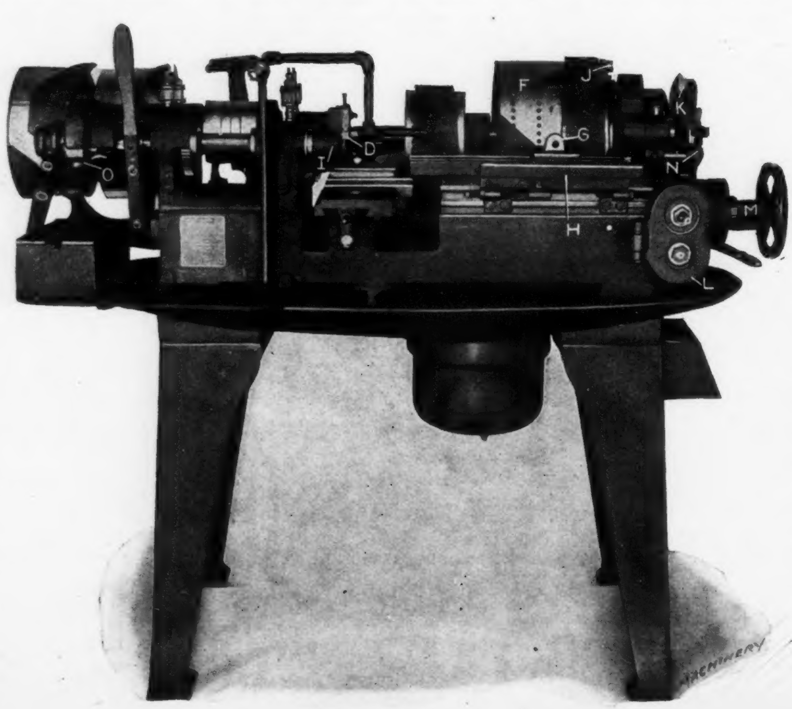


Fig. 3. Model G Cleveland "Automatic" with Turret Mechanism removed

Feed change gears are provided which enable the operator to obtain a rate of feed suitable for any kind of material which the machine is required to handle, whether it be

RATE OF PRODUCTION ON CLEVELAND MODEL G AUTOMATIC IN PARTS PER HOUR

Part	Brass	Steel	Part	Brass	Steel	Part	Brass	Steel
A	400	180	M	400	180	Y	450	200
B	140	70	N	600	300	Z	350	120
C	600	240	O	300	120	a	400	120
D	600	180	P	450	140	b	600	200
E	550	250	Q	500	240	c	1000	400
F	520	240	R	240	60	d	720	250
G	200	45	S	600	250	e	375	120
H	450	150	T	750	300	f	100	45
I	240	60	U	300	120	g	400	180
J	420	180	V	450	180	h	650	300
K	1600	750	W	360	120	i	400	80
L	180	65	X	1200	300	j	250	100

Machinery

brass rod or steel of any description. These change gears are mounted at *L* and are covered by the hinged guard. The positive pressure rotary oil pump is provided with a self-contained overflow, and this pump delivers a large volume of oil at heavy pressure. A greater pump capacity than is actually needed has purposely been provided. The distribution of cutting oil to the tools has been given much attention in this machine, oil feed being supplied to each tool hole in the turret, allowing a stream of oil to be delivered to the center of each tool wherever practicable. The piping which conveys the oil to the turret tools is shown at *N*, and individual streams of oil are also supplied to the slotting saw, the tool held in the shaving spindle and the cross-slide tools. This individual stream system allows the highest speeds and feeds to be employed and increases production to a wonderful extent. The balanced chuck operating fingers *O* at the rear of the spindle insure prompt opening and closing of the chuck, regardless of how high the spindle speed may be.

The machine may also be equipped with a high speed drilling attachment, giving the correct speed for any drill regardless of how small its diameter may be. This attachment may easily be applied to the machine at any time in a few minutes. On all machines, the hardened tool steel stud on which the turret is mounted is made with a hole through the center, ground to exact size ready to receive the driving shaft of the attachment. The revolving drill holder is held in one of the tool holes in the turret and gears connect this holder with the central driving shaft. One or more revolving holders may be used at the same time, all being driven from the central shaft. In cases of deep drilling, the drill may be backed out several times to clear the chips. This machine, which is exceptionally universal and adapted to all classes of work, is capable of holding sizes to within 0.0005 inch on the diameter and length, and will give continuous service with little attention on account of its extreme simplicity.

The following is a summary of the important features of this machine: 1. All working parts are readily accessible. 2. Setting up and changing from one job to another is extremely simple. 3. It does not require any great skill to make or change the shape of the cams. 4. All attachments are easily placed in position and just as easily removed. 5. The turret indexing mechanism is extremely simple; it indexes from one hole to the other in 1/5 second and vacant turret holes may be skipped. 6. An individual oiling system is provided which insures having oil on the cutting edge of the tools at all times. 7. The machine can handle exceptionally intricate work because of the various attachments which can work in combination. 8. The work is separated from the chips in all cases where the parts to be made are not over 1½ inch long on the ⅜-inch machine and 2 inches on the ⅝-inch machine. 9. A second operation is done away with on almost any shaped piece, because of the shaving attachment. 10. The machine is convertible from a turret to a plain machine and *vice versa*. 11. It is possible to slot both ends of a piece if desired. 12. The length of the turret stroke and the rate of feed are variable to suit each tool held in the turret.

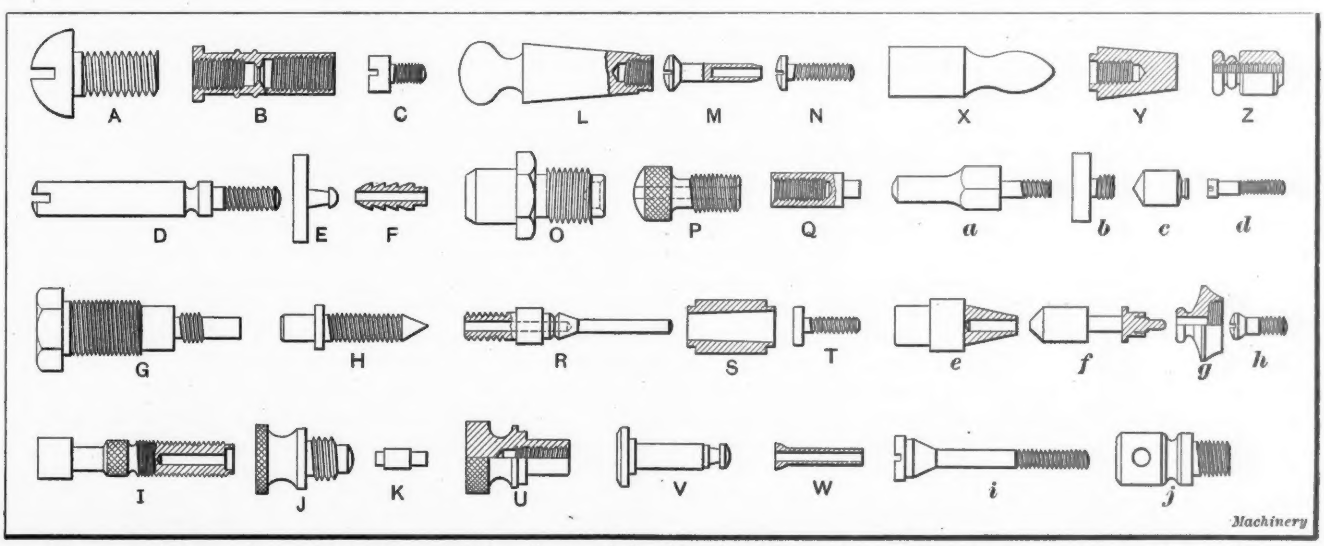


Fig. 4. Typical Examples of Work done on Model G "Automatic." Rate of Production for each Piece is given in Accompanying Table

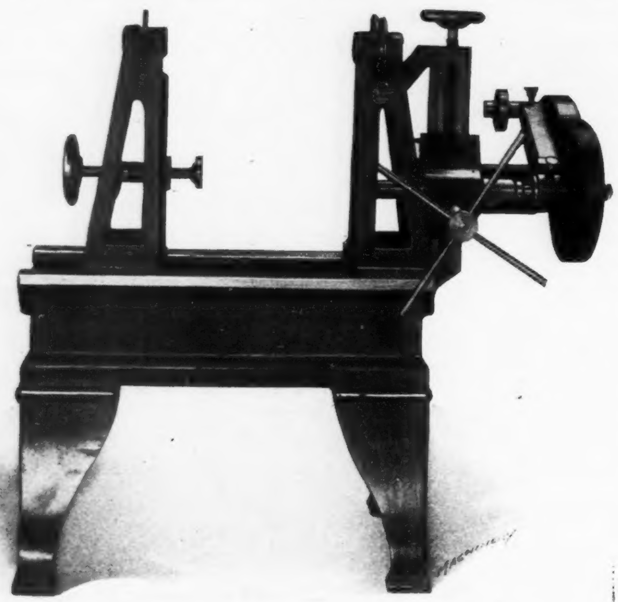
BRAZING STELLITE TO MACHINE STEEL

The high cost of stellite has in many cases made it out of the question to use tools made entirely of this metal, while its brittleness has been a drawback in holding stellite bits in tool-holders fitted with the usual form of set-screw for holding the bit in place. In order to overcome the difficulties resulting from these two causes, the Ready Tool Co., 654 Main St., Bridgeport, Conn., has been conducting experiments in the attempt to either weld or braze a small stellite cutter to a machine steel shank. Obviously this would be the means of overcoming the difficulties which the high cost and brittleness of stellite have thrown in the way of its practical application. A great many kinds of brazing material and fluxes were tried and various methods of welding were experimented with, but these proved unsuccessful for a long time. It seemed to be impossible to find any brazing material that would hold to stellite, the brass of the spelter rolling off as if the stellite had been greased. Welding was found no more satisfactory owing to the rapid expansion and contraction which took place in the metal, and also to the fact that when melted by the oxy-acetylene flame stellite becomes alloyed with the steel so as to seriously impair its cutting efficiency.

After many months of experimenting it was found that a number of factors were responsible for the lack of success which had accompanied the attempt to secure stellite to steel by the methods referred to. All of these factors were important and all of them had to be taken into consideration before the difficulty was finally overcome. In the first place a special brazing material was necessary and this material had to be used in conjunction with a special brazing flux. In addition to this, it was found necessary to heat the work to a certain specified temperature in order to get the spelter to flow properly, and at the same time not to penetrate into the stellite tool. After this information had been obtained it was found possible to braze stellite bits onto machine steel shanks with perfectly satisfactory results.

FAY & SCOTT BALANCING MACHINE

The accompanying illustration shows a combination balancing and drilling machine built by Fay & Scott, Dexter, Maine. The combination in a single machine of means for testing the balance of a wheel and then drilling to correct for any error in balance is naturally the means of greatly increasing the speed at which this work can be done. Where a plain balancing machine is used in connection with the drill



Fay & Scott Combination Balancing and Drilling Machine

press, it is obviously necessary to first determine the "heavy side" of the wheel and then take the wheel to the drill press on which the excess metal is removed. But as great care must be taken to avoid removing too much metal, it is generally necessary to shift the work back and forth between the balancing machine and drill press several times. Using this machine a man can balance forty flywheels in ten hours.

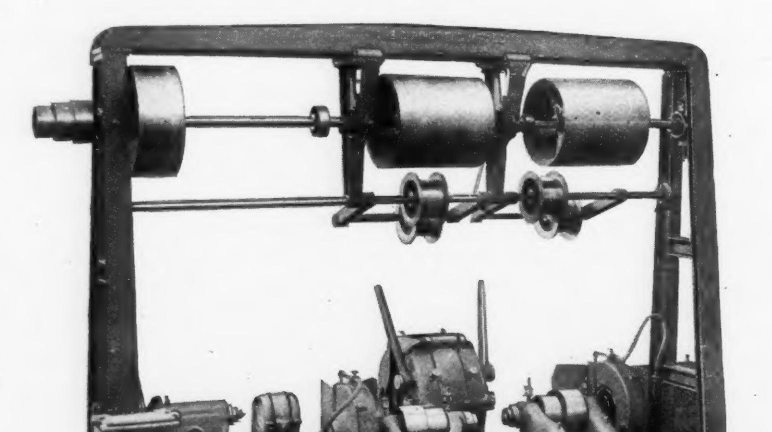
On the new Fay & Scott balancing machine, the mandrel carrying the wheel to be balanced is supported on hardened steel, knife-edge disks 6 inches in diameter. These disks are mounted in ball bearings so that they turn very freely to show slight errors in the balance of the work. The bed of the machine is of box section and carries a tailstock, which may be adjusted for flywheels of different face widths. The position of the headstock is fixed. The drill spindle has an in and out movement of 4 inches, this movement being controlled by a rack and pinion and operated by hand. A steadyrest is mounted on the tailstock, opposite the drilling spindle in the headstock; this steadyrest is screwed up against the flywheel before the drilling operation is started, thus holding the wheel firmly in place. The capacity of the machine is for flywheels up to 42 inches in diameter, and the minimum diameter of wheels that can be drilled is 13 inches. The vertical adjustment of the drill head is 14½ inches. The machine occupies a floor space of 65 by 25 inches and weighs 900 pounds.

SPRINGFIELD CAR-WHEEL GRINDER

The latest addition to the line of grinding machines made by the Springfield Mfg. Co., Bridgeport, Conn., consists of the No. 5 car-wheel grinder which is illustrated and described herewith. In designing this machine particular attention has been paid to the development of structural features capable of withstanding the hard usage to which machines of this type are subjected, and to the development of a design in which all operating mechanism is readily accessible. The machine is suitable for grinding steel or chilled cast-iron wheels mounted on axles of standard gage, the capacity being for wheels from 28 up to 44 inches in diameter. The grinding or truing of a pair of car wheels on this machine can be done on their own axle journals or on dead centers, as will be necessary in grinding truck wheel axles. It will be seen from the illustration that the machine is self-contained and driven by one belt from a main lineshaft; or by an individual motor according to the requirements of different users. An important point is that a crane can pass over the machine to lift the wheels in and out.

A clutch operated by hand levers from either side of the machine facilitates stopping the car wheel axle instantly at a point where the opening or gap in the gear is directed upward, thus permitting the removal of the axle and wheels. The widely spaced driving pinions are driven by one common shaft to insure their relative position at all times, and also to provide for overlapping the gap in the driven gear. Three different work speeds are obtainable for rotating the axle, and the operation of the grinding wheel heads traveling parallel with the axle is by hand. The feed is also by hand, large feed-screws running in long nuts being provided, with the end thrust taken by ball bearings. The slide bearings are long and narrow with adjustable taper gibs to provide compensation for wear. The grinding wheel spindles are driven by belts from overhead drums, and automatic tightening idlers insure the maintenance of the proper belt tension. The cone pulleys on the spindles provide two changes of speed for the wheels, and the grinding wheel spindles are carried in bronze bushed bearings of ample size. The heads can be swiveled to provide for grinding tapered work.

The tailstocks are of heavy construction and provided with large sleeves and feed-screws. As previously mentioned, the dead centers are used for grinding truck wheels and "wabble centers" are used to prevent side motion when the wheels are supported on the journals of their own axles. The journal rests are provided with different sizes of half shells which are adjustable for slight differences in the diameter of the journals. There is a pump which delivers an ample supply of water to keep the work cool, part of the bed being formed into a supply tank to which the cooling water is returned. It will be seen that hoods are provided over the wheels which confine the spray, thus preventing it from being thrown onto the operator and floor. Particular attention has been given to the subject of lubrication, and those bearings subjected to severe service are ring oiled. The principal dimensions of the machine are as follows: capacity for grinding car wheels from 28 to 44 inches in diameter; length of axles, up to 7 feet 10 inches; diameter



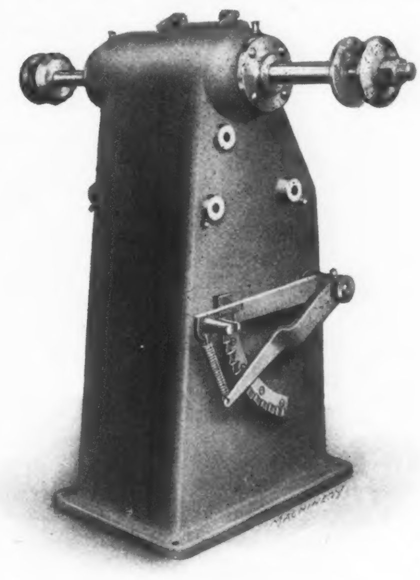
Springfield Car-wheel Grinder for truing Steel or Chilled Cast-iron Wheels

of axle journals up to 6 inches; size of grinding wheels, 18 by 2½ by 2½ inches; available wheel speeds, 1040 and 1350 R. P. M.; speeds of axle driving gear, 4.2, 5.3 or 6.5 R. P. M.; floor space occupied, 6 by 14 feet; power required to drive machine, approximately 20 horsepower; net weight of machine, including motor and accessories, 18,000 pounds.

GARVIN AUTOMATIC TAPPING MACHINE

The three machines shown in the accompanying illustrations are recent products of the Garvin Machine Co., Spring and Varick Sts., New York City. The machine shown in Fig. 1 is known as a 1-2 combination automatic tapping machine; this is essentially the No. 2 machine of this company's manufacture, equipped with a No. 1 auxiliary head. This combination meets the demand for a machine for tapping work with two holes, the sizes of which differ to such an extent that it would not be practical to have both heads of the same capacity. Referring to the illustration it will be seen that the No. 1 head can be operated by either a lever or foot treadle, while the No. 2 head is operated by a lever. Each head is independent of the other. Fig. 2 shows a machine known as a No. 1-2-X combination automatic tapping machine which consists of the No. 1 and No. 2-X heads mounted on a single machine. Both heads are treadle operated so that both of the operator's hands are left free. The No. 2-X head of this machine is of greater capacity than the No. 2 head on the machine shown in Fig. 1.

Fig. 3 shows a machine styled the Garvin 2-X four-spindle automatic tapping machine. It will be seen that the spindles are operated in pairs which are controlled by independent levers. The two spindles on the right-hand side of the machine are used for rough-tapping, while the two spindles at the left are reserved for finishing. The work consists of a deep hole in a tool steel part, the material making it necessary to rough-tap the hole before finishing, and this is done without requiring the work to be set up a second time. This result is obtained by the transverse slide which enables the fixture to be moved along to bring the work into position under the finishing spindles after the roughing operation has been performed. The general operation of these machines is the same as that of the regular Garvin automatic tapping machines, the spindles being fitted with two frictional pulleys running in opposite directions, and after the tap is once started the operation is automatic, the hole being tapped to a predetermined depth which is controlled by an automatic trip which stops and reverses the tap.



F. E. Wells No. 10 Polishing Machine with Spindle carried in Ball Bearings

F. E. WELLS POLISHING AND GRINDING MACHINE

The No. 10 ball bearing polishing machine illustrated herewith is a recent addition to the line of F. E. Wells & Son Co., Greenfield, Mass. This machine is designed to be driven from a shaft attached to the ceiling of the floor beneath that on which the ma-

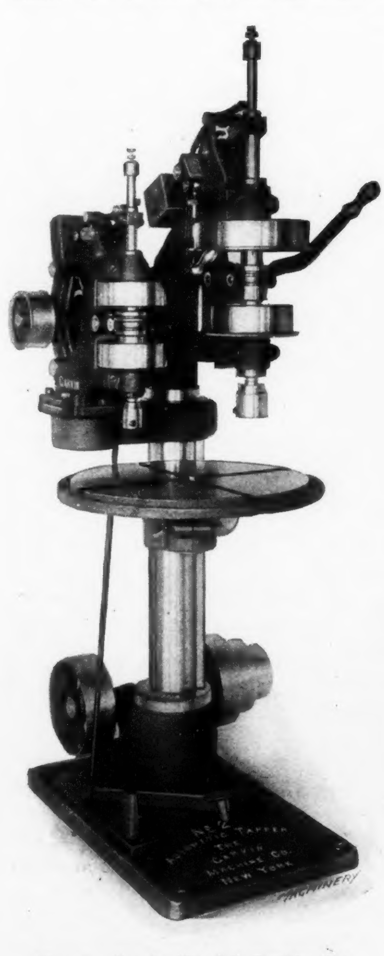


Fig. 1. Garvin No. 1-2 Combination Automatic Tapping Machine

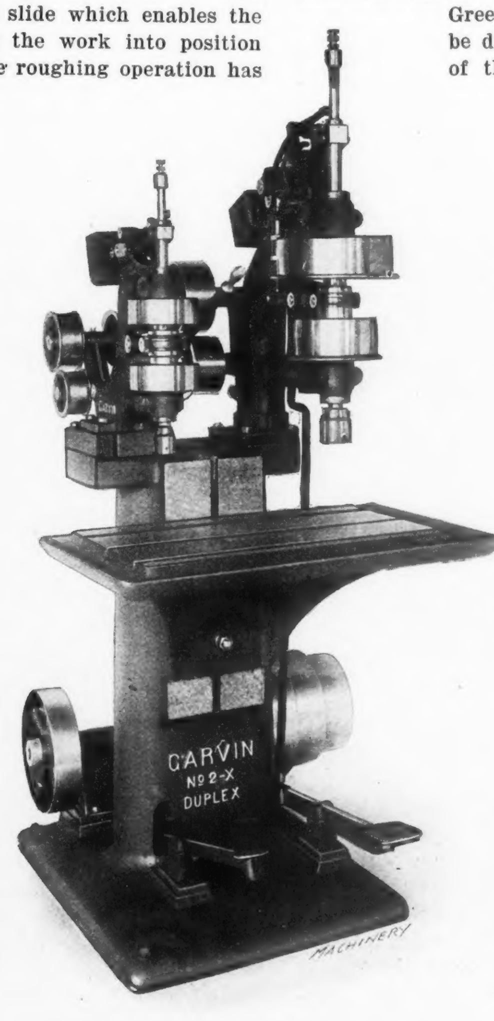


Fig. 2. Garvin No. 1-2-X Combination Automatic Tapping Machine

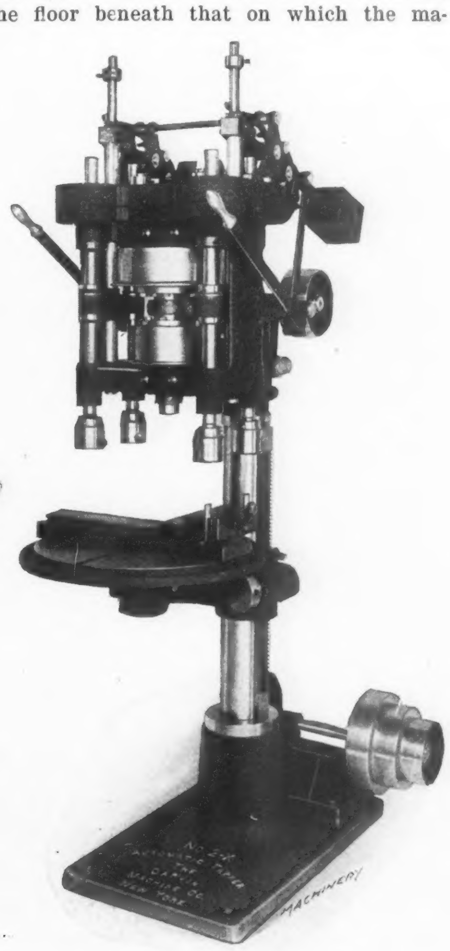


Fig. 3. Garvin No. 2-X Combination Automatic Tapping Machine

chine is set up, but in the case of single-story buildings, the driving shaft may be placed in a trench and its bearings supported by floor stands. Having the belt completely enclosed in this way is an important means of providing for the safety of the operator. The idler pulley for tightening the belt when it is required to start the machine is located inside the bed. This pulley is operated by the handle seen at the side of the machine, which is raised to bring the idler into contact with the belt to engage the drive; and to stop the machine, it is merely necessary to lower the handle. The spindle runs in SKF ball bearings which are carefully enclosed to provide for the exclusion of dust and grit. When so desired, tapered bronze bearings which are ring-oiled may be supplied in place of ball bearings. This machine is also equipped for grinding, in which case the spindle is shorter so that the grinding wheels are located close to the bearings. The principal dimensions of the machine are as follows: diameter of spindle, 1¼ inch; height of spindle from floor, 36 inches; size of base, 17 by 22 inches; and net weight of machine, 510 pounds.

A No. 11 ball bearing grinding machine is another recent product of this company. This is similar to the No. 10 machine except that it is arranged to be driven by an overhead belt. As in the case of the No. 10 machine, the spindle is mounted in SKF ball bearings, this form of mounting assuring maximum transmission efficiency with a corresponding reduction in the cost of power and maintenance. The principal dimensions of this machine are as follows: diameter of spindle, 1¼ inch; total length of spindle, 36½ inches; projection of spindle at each side of machine, 7 inches; height of spindle from floor, 36 inches; and net weight of machine, 425 pounds.

NEHLS PYROMETRIC PASTE

A means of measuring high temperatures, based on the same principle as that of the Seiger cones, has recently been developed by the Carl Nehls Alloy Co., 248 Brush St., Detroit, Mich. This consists of different metallic salts which are made up in mixtures that will melt at various specified temperatures ranging from 220 to 1330 degrees C. This method of measuring temperatures is intended to replace more costly pyrometers and also for the purpose of checking the indications of pyrometers. For the latter purpose, the pyrometer and a mixture of salts of a known melting point are placed in the furnace together. When the salt melts it shows that the temperature of the furnace has reached a specified point,

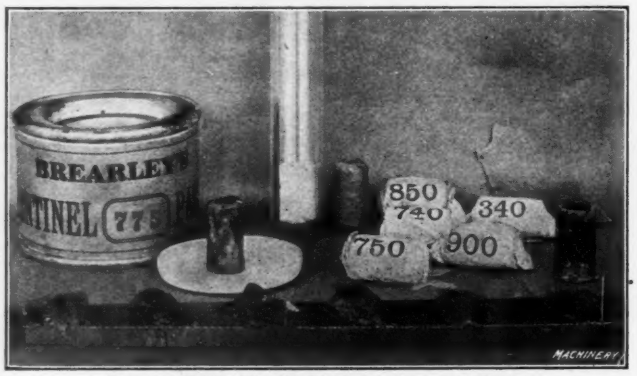


Fig. 1. Nehls "Sentinel" Pyrometers and Paste

and the indication of the pyrometer should correspond; otherwise the instrument is in error and should be corrected accordingly.

In use, these metallic salts are cast into solid cylinders 7/16 inch in diameter by 3/4 inch in length, as shown in Fig. 1. Each cylinder is wrapped in paper on which its correct melting temperature, in degrees C, is marked. For all temperatures below 485 degrees C or 932 degrees F, these cylinders or "Sentinel pyrometers" as they are called, can be used in an air-tight glass tube of the form shown. In this way, the same salt can be used over and over again, but where this method is not feasible, by placing the cylinder on a small porcelain saucer the melted salt is prevented

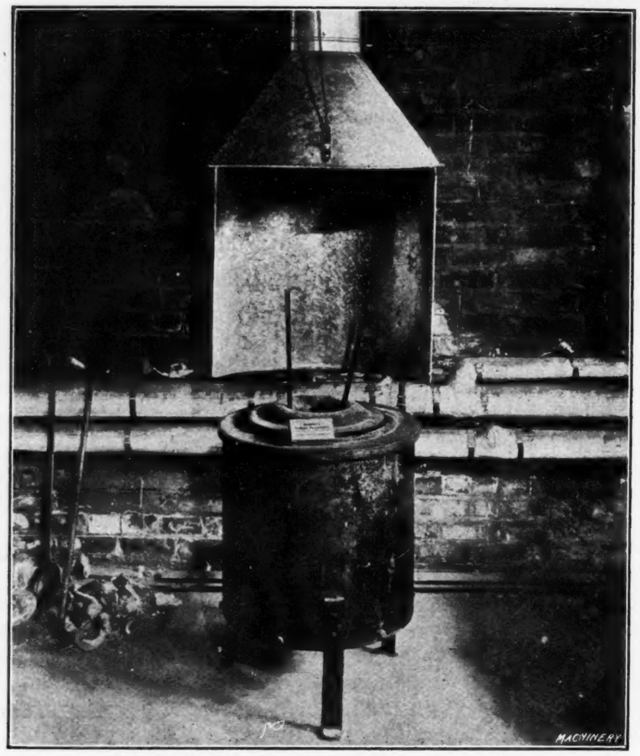


Fig. 2. Method of using "Sentinel" Pyrometers

from running over the floor of the furnace in which it is used.

These salt mixtures are also made in the form of paste, a sufficient quantity of paste to make several hundred determinations being packed in a tin, as shown. Daubs of different pastes of various melting points can be placed along a steel bar and inserted in the furnace, retort, flue or other point where it is required to make a temperature determination, and by noting which paste melts and which does not, the temperature may be determined, this temperature lying between the melting point of the paste which does not melt and that of the paste with the highest melting point which was reduced to the liquid state.

In the heat-treatment of tool steel, paste with a melting point corresponding to the temperature at which it is required to quench the steel is selected, and some of this paste is daubed on the tool, which is then placed in the furnace and its temperature raised until the paste melts. This shows that the steel has been heated to the required quenching temperature and the tool is removed from the furnace and plunged into the oil bath or other quenching medium. Another handy use of "Sentinel" cylinders is shown in the illustration Fig. 2. Two tubes or pipes are plugged at the bottom and "Sentinel" cylinders of different melting temperatures are dropped into these tubes. Rods are then placed on the tops of the cylinders and when the furnace has been heated sufficiently so that the cylinder with the lower melting point fuses, the rod on that cylinder drops. When one rod has dropped in this way and the other has not, it shows that the temperature of the furnace lies between the melting points of the two salts that were chosen. This difference may be only 10 degrees. The method referred to is found particularly useful in determining the temperature of molten metal, salt bath furnaces and numerous other classes of heating equipments.

EDWARDS STEEL TRUCKS

Reference to the accompanying illustration will show that the Edwards truck which forms the subject of this article is made entirely of steel, with the exception of the handles which are steam-bent timber. The axle bearings are supported by the U-shaped frame, which is one continuous piece and gives the maximum strength and rigidity. The frame is made of 2½ by ⅜ inch angle steel; and the cross bars are of 1½ by ⅜ inch steel T-sections. All joints are riveted, with the exception of the handles and the axle bearings, which are bolted

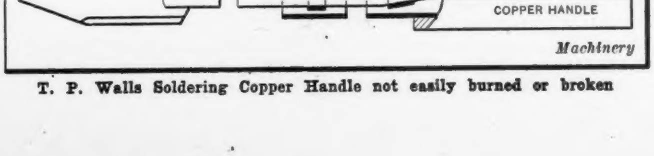
Edwards "General Purpose" Steel Truck

to the frame. In the event of a handle being broken, a new one can be quickly substituted; but as the handles are of straight grained wood reinforced with angle steel, it is very seldom that such an accident occurs. The handles are varnished and the remainder of the truck is painted black. A noteworthy feature of the design is that the wheels are located inside the body of the truck so that they will clear anywhere where there is room for the body of the truck to pass.

It is claimed that the increased durability of these trucks over those made of wood is so great that the elimination of breakage and upkeep expenses will pay for the truck in a year. The truck illustrated is what is known as the "general purpose" truck for use in factories, warehouses, etc. The same form of construction is followed in the "barrel and general cargo" truck, and the "cotton" truck made by this company. The latter truck is especially adapted for handling bales and similar heavy packages. Further particulars may be had from the Edwards Mfg. Co., Cincinnati, Ohio.

WALLS SOLDERING COPPER HANDLE

With the view of overcoming the difficulty experienced through the splitting or burning of the wooden handles of soldering coppers, T. P. Walls Tool & Supply Co., 83 Walker St., New York City, has introduced the handle which forms the subject of this description. It will be seen that this handle consists of a metal sleeve which projects out from the handle proper that is made of wood. This metal sleeve which receives the shank of the soldering copper is cut and formed in a die so that the shank is a forced fit in the sleeve as shown. Forcing the shank into the sleeve places the sleeve in tension which gives it a very tight grip on the shank, it being claimed that this grip is almost as secure as if the two parts were welded together. This projecting metal sleeve protects the handle from being burned, while the wooden grip prevents it from getting too hot. This effect is further augmented by the hollow handle which allows air to circulate through it. Handles of this type are made in three sizes, known as Nos. 1, 2 and 3, which have capacities for soldering copper ranging from 1 to 6 pounds in weight.

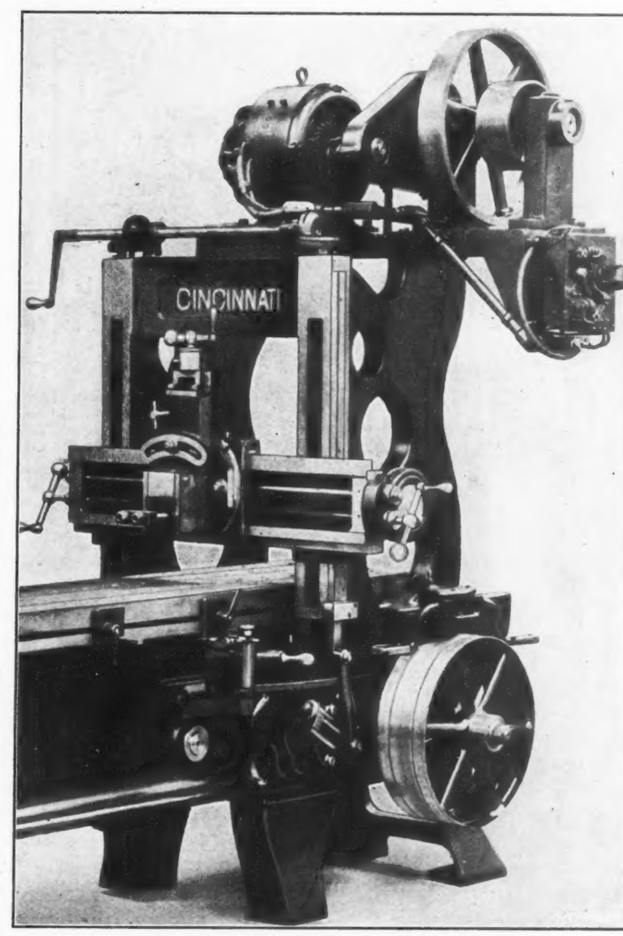


T. P. Walls Soldering Copper Handle not easily burned or broken

MOTOR DRIVE FOR CINCINNATI PLANER

In the January, 1909, number of MACHINERY, reference was made to a 22-inch planer which was then a new product of the Cincinnati Planer Co., Cincinnati, Ohio. This company now makes announcement of a machine of quite similar design with the exception of the fact that it is equipped with the arrangement of individual motor drive shown in the accompanying illustration. The machine is entirely self-contained and completely wired in conduit; and the starting box is attached as shown in the illustration, making a very neat and simple installation. The upper driving shaft runs in bronze bushed ring-oiled bearings which are fastened to a top plate that carries the motor and starting box. This makes the drive a complete unit, and mounting the starting box at the extreme end of the plate—on the outside of the belts—eliminates the necessity of reaching between the belts to start the machine—a practice which may result in injury to the operator. All gears are also adequately covered.

The bed is bored to receive the driving shaft bearings which are internally ground. The loose pulleys are bushed with self-oiled bronze bearings, and micrometer collars are provided for both the horizontal and vertical feeds. The



Arrangement of Motor Drive for Cincinnati Planer

large feed gear at the end of the rail is of improved design in which the flat spring and pawl have been dispensed with. Nothing but the operating handle is exposed. Because of the ease of manipulation and rapidity of operation, this machine is especially adapted for manufacturing small duplicate parts, as well as the ordinary run of planer work. It is also particularly well suited to the requirements of trade and technical schools.

LANGELIER SEMI-AUTOMATIC MULTIPLE TAPPING MACHINE

The No. 2 semi-automatic multiple spindle tapping machine illustrated in Figs. 1 and 2 is one of the recent additions to the line of the Langelier Mfg. Co., Providence, R. I. This machine is adapted for tapping practically any number of holes grouped within a five-inch circle and arranged on almost any

layout. Ample power is provided for driving as many as sixteen 1/8-inch taps, or their equivalent, in cast iron. The machine is semi-automatic in operation and may be readily attended by the same grade of help usually employed to operate single spindle tapping machines, as the duties of the operator are reduced to merely placing the work to be tapped in the locating fixture, starting the machine by tripping the foot treadle and then removing the finished work. In addition to the multiple head furnished with each complete machine, additional heads—each having a different layout of spindles—can be used interchangeably, so that the machine is adapted for tapping a great variety of parts.

The tapping spindles are of the crank type, driven from a common driving plate without gearing; and the spindle driver is carefully balanced to eliminate practically all noise and vibration when the taps are running at their normal cutting speed. The spindles are machined from solid alloy steel bars,

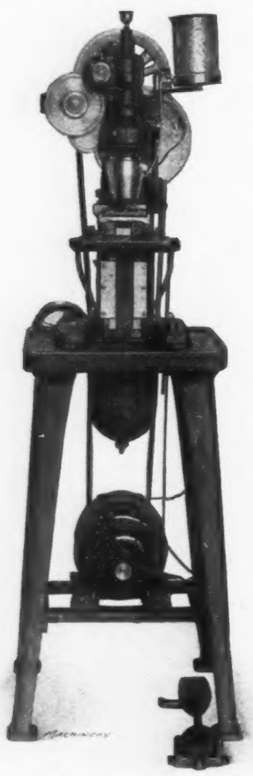


Fig. 1. Front View of Langelier No. 2 Semi-automatic Tapping Machine

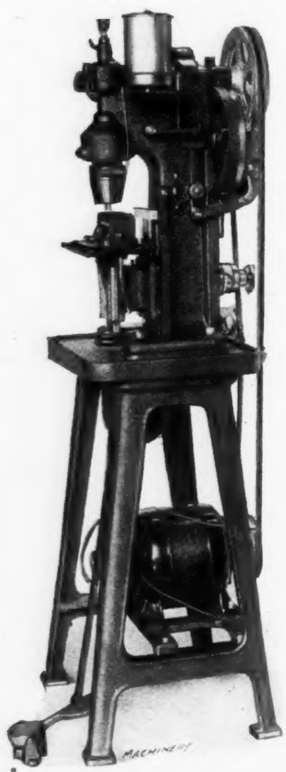


Fig. 2. Side View of Langelier Tapping Machine showing Arrangement of Drive

after which they are heat-treated and carefully ground to size. The chucks were designed by the Langelier Mfg. Co. for taking straight-shank tanged taps. The spindles are located with extreme accuracy on fixed centers and run in hard phosphor-bronze bushings. Each spindle is fitted with a special compensating device which allows individual taps to follow their own leads; and by this means every hole is tapped with clean cut threads. This compensating feature also permits of simultaneously operating taps of different pitches, and insures uniformly accurate and interchangeable work. Each tap is kept properly lubricated by letting a thin film of oil run down to it, the oil for this purpose being delivered from the reservoir casing which is clamped around the multiple head. Oil is delivered to the casing from the large oil reservoir at the right-hand side of the machine.

The machine proper consists of a rigid cast-iron column which is mounted on a table supported by legs of the form shown. This column carries the main vertical spindle which drives the tapping head. The main spindle is driven through spiral and spur gearing by a set of three grooved pulleys mounted side by side at the back of the machine near the top, the arrangement being clearly shown in Fig. 2. These pulleys are grooved to receive a 1/2-inch built-up round leather belt, this form of belt being adopted because it permits of a very sharp reversal of the taps without shock; and also because the amount of floor space occupied by the machine is less when using a round belt than would be the case if a flat belt were employed. The inner of the three pulleys drives the taps forward and actuates the mechanism which raises the table at the proper rate for the pitch of taps which are being used. The outer pulley reverses the taps, and also lowers the table at twice the tapping feed. When the taps are clear of the work or jig, the machine is stopped automatically and the operator is given just sufficient time to take out the tapped piece and replace it with a fresh blank. The belt is then shifted mechanically, driving the taps forward and feeding the table up, this cycle of operations being repeated over and over and timed to secure the greatest practical tapping speed. The middle one of the three grooved pulleys is an idler or loose pulley to which the belt is shifted to stop the machine. The shifting of the belt is controlled by a pilot gear which derives its motion from the change gears shown at the left-hand side of the machine in Fig. 1. T-slots are provided on this pilot gear which carry adjustable dogs that operate the belt shifting fork. One dog simply shifts the belt to the idle pulley and stops the machine. The other dog shifts the belt to the outside pulley and reverses the motion of the taps and table. Adjustable stops are provided which may be accurately set to prevent loss of time from over-travel.

To start the machine the operator simply trips the foot treadle. This shifts the belt from the center or loose pulley to the inner or driving pulley and at the same time places the belt shifter in position to be engaged by the reversing dog which shifts the belt to the outer or reverse pulley. The position of the dog which shifts the belt to the loose pulley is fixed, but the reverse dog is set to suit the thickness of the work which is to be tapped. On the inside face of the pilot gear which carries the tripping dogs there is a face-cam which actuates the rise and fall of the table, this movement of the table corresponding with the pitch and speed of the taps. When it is necessary to place taps in the spindles or remove them, the knee which carries the table must first be lowered. The friction disk is graduated and after the change has been made care must be taken to bring the pointer back to the same graduation on the disk in order to bring the table back to its original position. The principal dimensions of the machine are as follows: maximum distance between table and tapping chucks, 5 inches; distance from center of main driving spindle—which coincides with the center of the tapping head—to the face of the column, 3 1/2 inches; diameter of driving pulley, 9 inches; power developed by driving motor, 1/4 horsepower; diameter of grooved pulley on motor spindle, 5 1/2 inches; total height of machine, 61 inches; floor space occupied, 22 by 20 inches; height of table from floor, 44 inches; and size of table, 5 by 8 inches.

LANDIS CHASER GRINDER

The chaser grinder which is illustrated and described herewith has recently been perfected by the Landis Machine Co.,

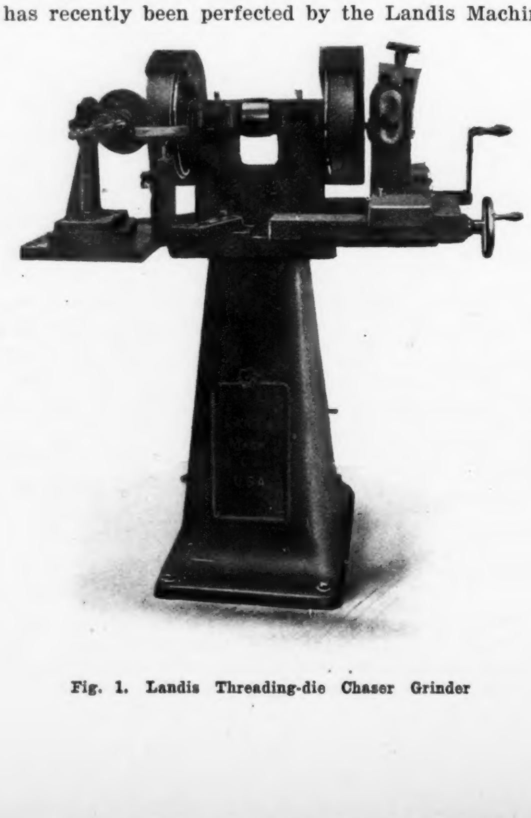


Fig. 1. Landis Threading-die Chaser Grinder

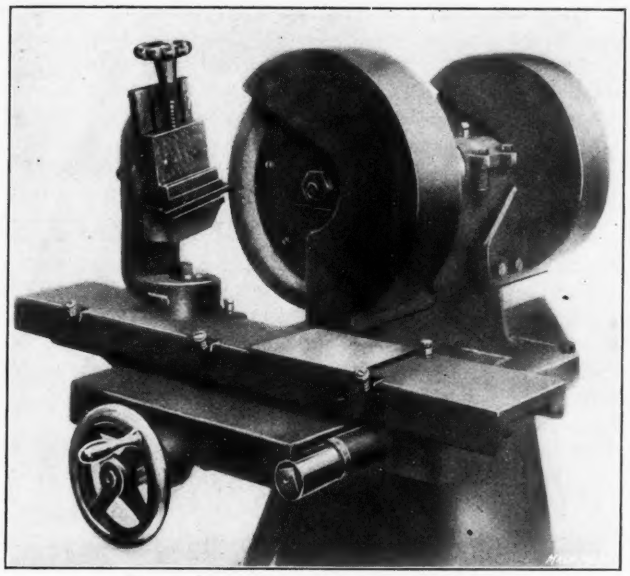


Fig. 2. Close Side View of Grinder Head

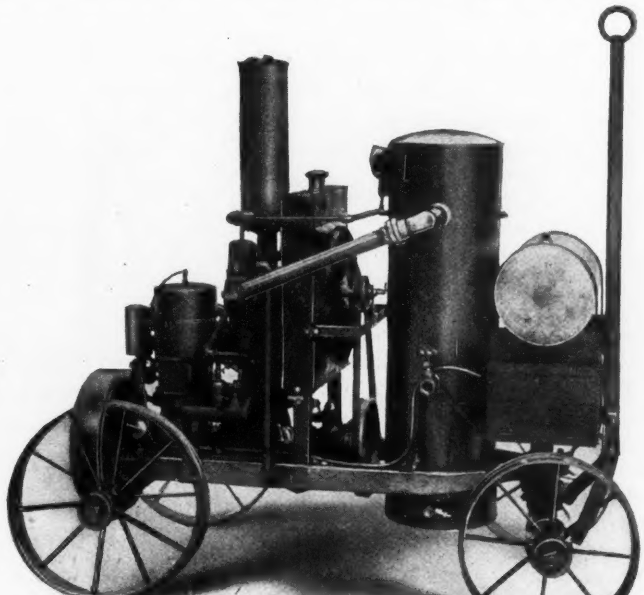
Inc., Waynesboro, Pa., for grinding thread-cutting dies, the machine being particularly adapted for grinding the threading die manufactured by the Landis Machine Co. The machine is duplex in that it is equipped with an attachment for grinding all sizes of Landis chasers, and a device for sharpening the disk cutters of roller pipe-cutting machines. It may also be used to advantage in grinding lathe, planer and shaper tools.

The chaser grinding attachment has adjustment in both horizontal and vertical planes with suitable graduations for controlling the lead and rake angles. Both the transverse and longitudinal feeds are in horizontal planes, which is a feature that tends toward increased accuracy. The table is gibbed at both sides and finished with an overhang to protect the guides from emery dust.

The disk cutter grinding attachment is also adjustable vertically and horizontally and is operated by hand. An adjustable rest is also provided to facilitate handling miscellaneous work. The rigid construction, guarded wheels, ease with which the machine can be operated, and its universal adaptability are features which will commend this machine to the attention of the experienced mechanic.

INGERSOLL-RAND PORTABLE AIR COMPRESSOR

The small portable air compressor driven by a gasoline engine, which is illustrated and described herewith, has been developed by the Ingersoll-Rand Co., 11 Broadway, New York City, to meet the requirements of industries that use compressed air in small quantities. The equipment is especially intended for the use of contractors who have temporary work requiring the use of air tools. The compressor being portable and self-contained, is admirably adapted for this class of service. It is driven by a single-cylinder gasoline engine which is direct-connected to the compressor with both pistons working on the same crankshaft. The engine is of the two-cycle type, its design following closely along the lines of standard marine engines. The air compressor is the Ingersoll-Rand Co.'s standard type known as the "Imperial XII," and has a capacity for delivering 45 cubic feet of air per minute at a pressure of 90 pounds per square inch. Cooling is provided for by a gear-driven pump and an automobile type radiator which serves both the compressor and gasoline engine cylinders.

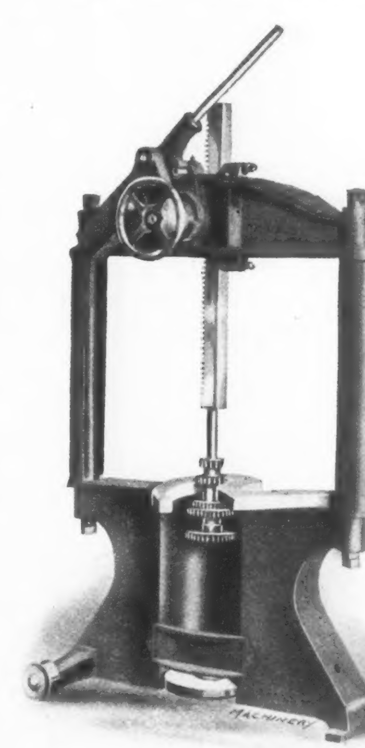


Ingersoll-Rand "Imperial XII" Portable Air Compressor

The frame, axles and wheels of the truck are of steel, and the front axle is connected to the frame by a swivel connection to provide for turning corners, etc., while sufficient vertical movement is provided to accommodate the wheels to inequalities of the road over which the truck is pulled without straining the frame. The air receiver is tested to 300 pounds per square inch and fitted with a safety valve, pressure gage and the necessary piping outlets, etc. The receiver is mounted at one end of the frame and a gasoline tank with a capacity of 15 gallons is supported on top of the tool-box as shown. The complete outfit weighs 1600 pounds and can be easily pulled about by hand, although it may be fitted with thills and single-tree for hitching a horse to haul it about, if desired.

ATLAS ARBOR PRESS FOR AUTOMOBILE WORK

The Atlas Press Co., 314 North Park St., Kalamazoo, Mich., which is the successor to the G. T. Eames Co., has recently placed upon the market a No. 26 and a No. 28 arbor press which are particularly adapted for automobile work. The design and construction of these presses has been worked out in a way to combine high power and rigidity. Several improvements have been applied, among which the following may be mentioned. The swinging plate over the opening in the base of the press may be instantly adjusted for any size of work; the bearing on the ram is exceptionally long; and the front of the press is accessible from any point. A lock is provided on the ram so that it may be held in any desired position. The rigid construction of these presses makes them well suited for handling heavy work in automobile factories, repair shops, etc.



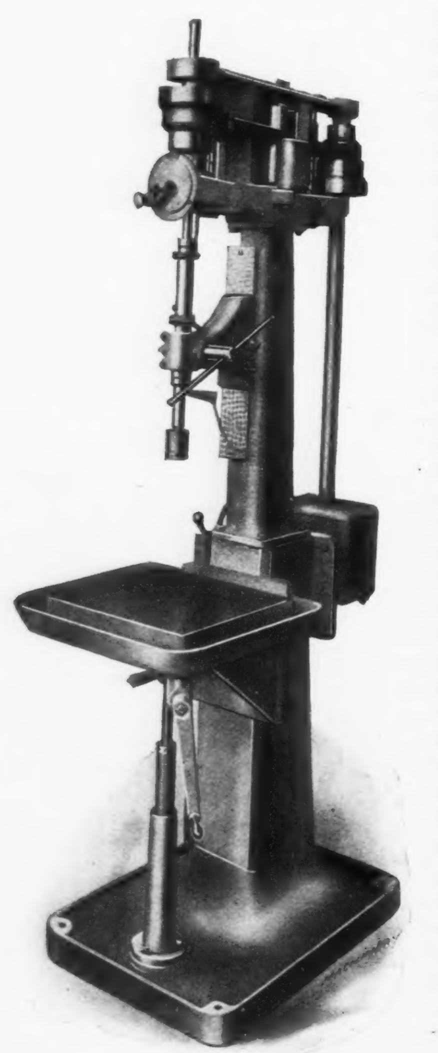
Atlas Arbor Press especially adapted for Automobile Work

SIPP MACHINE CO.'S SENSITIVE DRILL PRESS

In using many sensitive drill presses, where the variation in the size of the holes to be drilled is such that frequent changes must be made in order to obtain the proper cutting speed in each case, a considerable loss of time is inevitable

in shifting the belt; and the elimination of this difficulty has been given careful consideration in designing the line of sensitive drill presses which have recently been placed upon the market by the Sipp Machine Co., Paterson, N. J. Referring to the illustration, it will be seen that there is a pair of four-step cone pulleys at the top of the machine, and the belt is shifted to any of the steps on these pulleys by turning the small crank handle which will be seen at the front of the head. This handle rotates over an index dial which is graduated to show the number of revolutions per minute at which the spindle runs with the belt on each of the cone pulley steps. The speed changes obtained in this way cover a range which provides suitable speeds for drills from the smallest up to 29/32 inch in diameter; and the driving pulley may be arranged to run at 380 revolutions per minute for driving carbon steel drills, or at 525 revolutions per minute when high-speed drills are to be used in the machine.

It will be noticed that the belt is perfectly straight—without twists or turns—which is the means of adding materially to its life as there are no excessive strains put on either edge of the belt. Long idler pulleys on the slack side of the belt provide for keeping it at the proper driving tension. Convenience of operation has been carefully considered in providing means of control for all parts of the machine, and reference to the illustration will show the successful way in which this result has been attained. Both the crank for raising and lowering the table, and the lever which operates the shifter on the main driving belt, are within easy reach from the front of the machine so that there is no need for the operator to leave the working position.

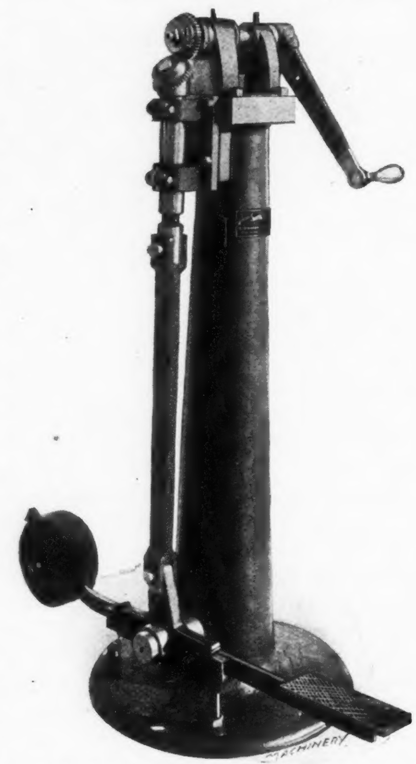


Sipp Sensitive Drill Press

The spindle is made of steel, accurately ground to size; and a ball thrust bearing takes the thrust of the spindle. An improved form of spindle oiling device in which there are no oil holes to clog provides adequate lubrication at all times, and there is an adjustable stop collar which can be set for any required depth of hole. The spindle driving cone pulley runs on ball bearings which take the entire belt pull, thus relieving the spindle from all strain. It has already been mentioned that idler pulleys take up the slack in the belt to maintain a satisfactory driving tension. One of these idlers is fixed, while the other is carried on a swinging arm and is pressed against the slack side of the belt by a light spring which maintains the required belt tension. It will be seen that the table is provided with an oil groove of ample capacity and that the sides of this oil groove are inclined—a feature which facilitates the removal of chips. The telescopic table elevating screw avoids the necessity of boring a hole in the floor. The table is rigidly locked to the base by means of a gib. The principal dimensions of the machine are as follows: maximum distance from table to spindle 32½ inches; diameter of spindle, ⅞ inch; traverse of spindle, 14¾ inches; taper hole in spindle, Morse No. 2. These machines are built with from one to eight spindles.

NOBLE & WESTBROOK MARKING MACHINE

A marking machine for graduating and numbering beveled fuse caps in a single operation, has recently been placed on the market by the Noble & Westbrook Mfg. Co., Hartford, Conn. This machine is of simple construction, easy to operate and it is said that the accuracy of the work is all that can be desired. The graduating die is carried in a holder keyed to the shaft. As the mark is made, the shaft revolves with the die and winds up a spring which returns the workholder to the proper position for marking the next piece as soon as the contact of the die with the work is broken. The shaft runs in adjustable bronze bushings and the work is held in the proper relation to the die by means of accurately cut gears, the impression being obtained through foot pressure applied by the treadle. Means of adjustment are provided so that the depth of the impression may be regulated to 0.01 inch. This machine is not only suitable for graduating fuse caps, but it could be employed on any beveled surface, such as micrometer collars of machine tools, etc. It could also be used to put lettering on beveled surfaces instead of graduations. The rate of output is very satisfactory, as it is only necessary to turn the handwheel once to complete marking the work.



Noble & Westbrook Machine for marking Beveled Fuse Caps

ECLIPSE ROLLER BEARING DRILL CHUCK

A roller-bearing drill chuck which can be tightened, ready to start drilling, with the thumb and forefinger, without requiring the use of a key or wrench, is the latest product of the Eclipse Machine Co., Elmira, N. Y. The saving of time effected through the use of a chuck of this kind on high-speed drilling machines, screw machines and other machines of which hard accurate work is required will be evident without requiring any detailed discussion of this feature. As tightened ready to start drilling, the chuck takes a grip on the drill which effectually overcomes the possibility of its dropping out from vibration; and then when the drilling operation begins, the jaws are tightened automatically by the resistance of the cut so that the grip is always proportional to the severity of the work being done by the drill. After the drilling

Fig. 1. Eclipse Roller Bearing Drill Chuck

operation has been finished and it is required to remove the drill, the chuck opens without noticeable resistance.

Having explained the features of this tool so far as its use is concerned, we will turn our attention to the way in which it operates. The shank *A* may be either a straight or Morse taper, according to the requirements of the machine. Referring to the cross-sectional view shown in Fig. 2, it will be seen that the shank enters a socket in the head *B*. Through the opposite end of this head there is a hole which is tapped to receive the threaded shank of the thrust member *C*, which has three grooves cut in it to receive projections *D* on the upper ends of the chuck jaws. It will be noticed that the mechanism is enclosed by the chuck body *E*, the ring *F* and the hood *G*, these three parts being screwed together to form a single unit which surrounds the chuck mechanism, the body being grooved to receive the jaws. In order to reduce the frictional resistance, rollers *H* are provided, these being of such a size that they are equivalent to ball bearings 3/8 inch in diameter. It will be seen that the outer faces of the chuck jaws are tapered to correspond with the taper on the inside of the hood *G*.

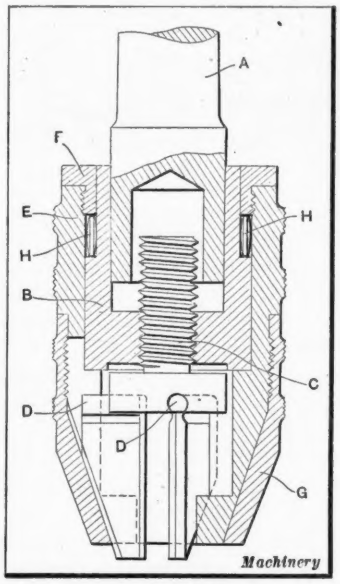


Fig. 2. Cross-sectional View of Eclipse Drill Chuck

When the operator desires to put a drill in the chuck he takes hold of the knurled chuck body *E* between his thumb and index finger, thus holding it stationary. The shank *A* and head *B* which is secured to it are rotated by the drill spindle and this rotation of the head *B* around the threaded shank *C* results in forcing down the thrust member and chuck jaws. Owing to the taper of the jaws engaging the hood *G*, the jaws are forced in, thus securing a grip on the shank of the drill. Then when the drill starts cutting, this grip is increased according to the resistance offered to the cut.

WALTHAM CUTTER GRINDER

The cutter grinding machine illustrated in Figs. 1 and 2, which is a recent product of the Waltham Machine Works, Newton St., Waltham, Mass., is designed for the purpose of grinding all kinds of angular cutters which are not over 2½ inches in diameter. The cutter to be ground is clamped in position on one end of the work-spindle, and an index plate is attached to the opposite end of the spindle. This arrangement gives more room for the grinding wheel and affords a positive means of indexing.

Fig. 1 shows the machine arranged for grinding the faces of the teeth or "gumming" as it is sometimes called. The grinding wheel is carried by a hardened steel spindle which runs in ball bearings. After the teeth have all been ground on the face, the cutter is mounted on the arbor in the reverse position to finish the grinding. In Fig. 2 the machine is shown adjusted for grinding one angle of a 60-degree angular cutter. The tooth to be ground is on the center of the axis of the spindle; and the cutter-holding spindle can be swiveled in a vertical plane to give the required relief.

Fig. 1. Waltham Cutter Grinder arranged for "gumming" Face of Teeth

The principal features of the design of this machine are as follows: A water pump and reservoir are provided to deliver a copious flow of cooling water to the tool, and an adjustable hood prevents the water from being thrown on the operator or floor. The hand indexing device is rapidly operated and a large dial provides for accurately setting the slide to the required angle. The grinding slide is furnished with adjustable stops in each direction, and this slide also carries a bracket with idler pulleys so that the machine can be driven from above and still have the vertical adjustment relative to the grinding wheel slide. While this machine is particularly adapted for grinding the cutters used on the Waltham thread milling machine, it may be used to advantage in grinding all kinds of angular milling cutters with ground cutting edges. The base is 14 by 19 inches in size and the weight of the machine is 182 pounds.

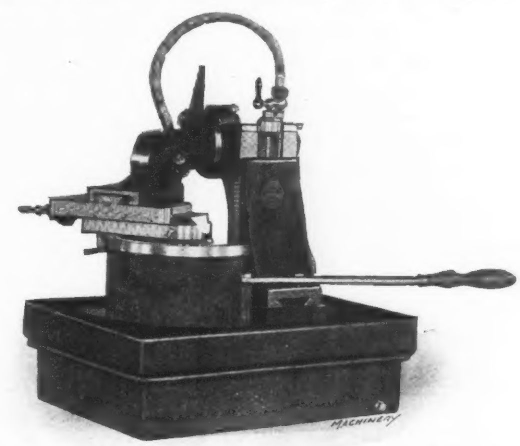
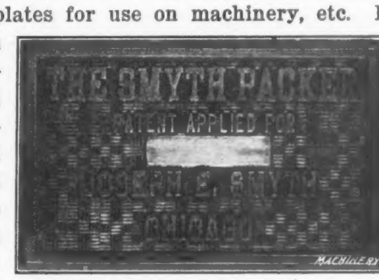


Fig. 2. Waltham Cutter Grinder adjusted for grinding One Angle of a 60-degree Angular Cutter

FEDERAL NAMEPLATES

The Federal Nameplate & Novelty Co., 732 Federal St., Chicago, Ill., has recently perfected a process for the manufacture of metal nameplates for use on machinery, etc. By this process the design stands out in bold relief and it is claimed that by having the letters and design raised instead of etched into the surface, a far more durable plate is secured and one which possesses a higher publicity efficiency. The plates are made of a special metal mixture which is hard enough to prevent the surface from being easily defaced. These plates are made of any required size and thickness and can be finished with a copper, brass or silver finish, as required. They are given a high polish and are not readily tarnished.



Federal Nameplate with Raised Letters

HOBART CIRCULAR SAW GUARD

An adjustable circular saw guard, which possesses several noteworthy features, has recently been developed by Mr. Hobart W. Curtis, foreman of the pattern department of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. Fig. 1 shows the guard in the working position; in Fig. 2 it is shown raised vertically to clear the saw; and Fig. 3 shows the guard swung over to one side so that it is entirely out of the way.

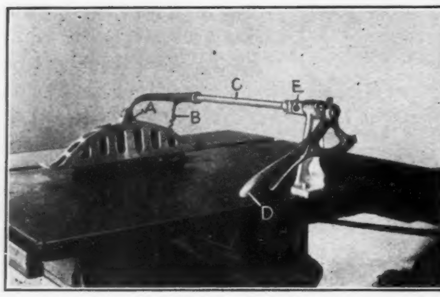


Fig. 1. Hobart Saw Guard in Working Position

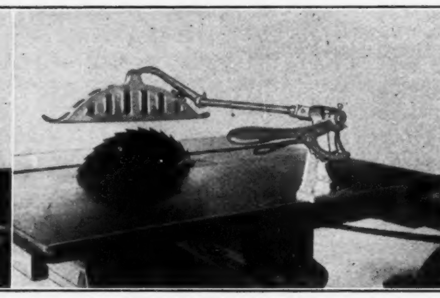


Fig. 2. Guard partially raised from Saw

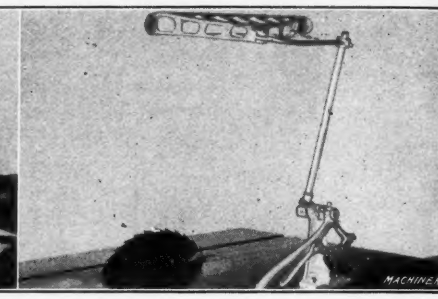


Fig. 3. Guard swung back out of Operator's Way

Referring to Fig. 1 it will be seen that the guard swings on the pivot *A*, while it is prevented from swinging far enough to hit the saw by means of the chain *B*. The vertical position of the arm *C* which supports the guard is regulated by the handle *D* that actuates the ratchet and pawl for the purpose of locating the guard at the proper height from the saw. It will also be noted that the arm *C* is pivoted at *E* so that the guard may be swung back when not in use, as shown in Fig. 3. The guard proper is made of aluminum, while the other parts are of steel or iron. The guard may be quickly adjusted to any of the positions shown in the illustrations.

WILLMARTH RADIAL DRILL

The Willmarth Tool Works, 1516 E. Thirty-second St., Cleveland, Ohio, has placed on the market the radial drill shown in Figs. 1 and 2. The design of this machine represents a departure from the established practice in building machines of this type and several advantages are claimed for this form of construction. The most prominent feature is the way in which the head and arm are moved to locate the spindle for the holes that are to be drilled. Referring to the illustrations it will be seen that the head rotates about a bearing on the arm, while the arm rotates about the column in the usual way. This affords a double swivel motion which enables the spindle to be easily located for any hole within the capacity of the machine. The bearing of the head on the arm is 17 inches in diameter and is provided with an annular ring on the inside for holding it central; and a heavy pivot bolt serves to hold the two members together. A powerful eccentric clamping mechanism locks the head in place on the arm.

The column is of the post and sleeve type. The post has a heavy lower portion which extends up to the top member that is securely bolted to it, the construction being one which affords ample stiffness. The column sleeve telescopes over the post and has a bearing at both the top and bottom in addition to a ball thrust bearing at the lower end, making it an easy matter to swing the arm into any required position. The sleeve is equipped with a powerful binding clamp at its lower end, and when this is tightened it produces essentially the equivalent of a solid column. The arm is a heavily ribbed cylindrical section which affords ample rigidity. It is raised or lowered by means of gearing at the top, which actuates a coarse pitch screw hung on ball bearings. Eight changes of speed are available, ranging from 35 to 375 revolutions per minute, these changes being arranged in geometrical progression. Four changes are obtained by the cone pulleys and the other four by the back gearing which is provided in the spindle driving gears. Provision is made for handling tapping operations by means of a jack shaft in the head, which runs at high speed and drives through an arrangement of powerful ring clutches. These clutches are self-adjusting and operated by a lever at the front of the machine, which makes it an easy matter to start, stop or reverse the spindle. The spindle is made of special steel; it is accurately ground to size and equipped with a ball thrust bearing. The hole is No. 5 Morse taper.

The feed mechanism consists of a selective gear-box which drives a worm and wormwheel that transmits the motion to the feed pinion. Six changes of feed are provided, ranging from 0.006 to 0.027 inch per revolution of the spindle. Any of these rates of feed may be instantly obtained by operating a dial located on the front of the feed-box. A quick-return handwheel is carried on the end of the feed pinion shaft.

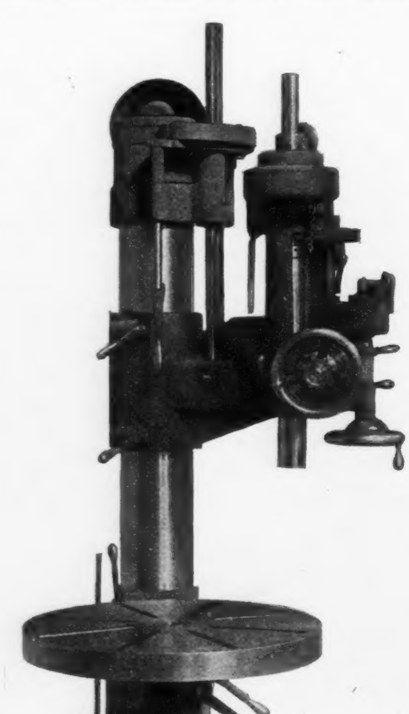


Fig. 1. Front View of Willmarth Radial Drill

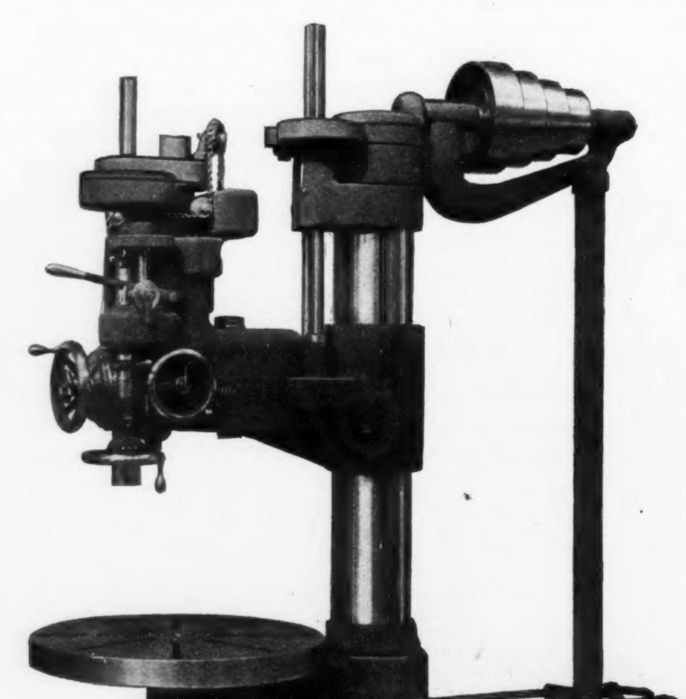


Fig. 2. Side View of Machine shown in Fig. 1

All bearings are bronze bushed and particular attention has been paid to the provision of adequate oiling facilities. No cast-iron gears are used in the machine, the gears being of steel, bronze or "semi-steel," according to the service which is required of them. All gears are fully guarded to provide for the safety of the operator. The machine is usually equipped with a round table of the form shown in the illustrations, but other styles of tables can be provided if required. The principal dimensions of the machine are as follows: Capacity to drill to the center of a circle 48¾ inches in diameter; maximum distance from spindle to base, 52½ inches; maximum distance from spindle to table, 27 inches; vertical traverse of spindle, 11¼ inches; vertical traverse of arm on column, 28 inches; total height of machine, 96 inches; and weight of machine, 3500 pounds.

VALLEY CITY MULTIPLE SPINDLE DRILLS

Fig. 1 shows a four-spindle drilling machine which has recently been placed on the market by the Valley City Machine Works, 12-16 Campau Ave., Grand Rapids, Mich., and Figs. 2 and 3 show front and rear views of a thirty-four-spindle machine which is another recent product of this company. These machines are particularly intended for drilling holes in pipe, the drilling operations being performed on opposite sides of the pipe simultaneously. It will be seen that the machine consists essentially of a rail supported by the required number of legs, with the drill spindle brackets carried on the rail. The rail is set at an angle which enables the operator to handle the work with the least amount of manual effort. In addition to acting as a support for the drill spindle brackets, the rail also carries self-centering clamping jaws which are operated by a splined shaft, worm gears and a rack and pinion. All spindles are adjustable both in regard to their center distances and vertical position, the vertical adjustment being for the purpose of compensating for differences in the lengths of the drills.

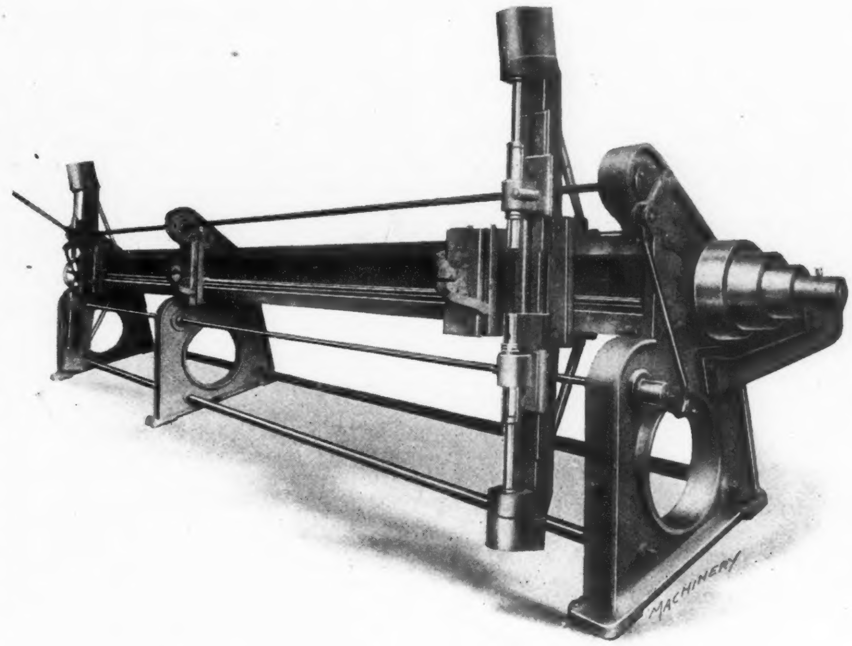


Fig. 1. Valley City Four-spindle Drilling Machine

On the four-spindle machine which is 20 feet long, the feed is obtained by a hand lever at the left-hand end of the machine. On the thirty-four-spindle machine, power feed with automatic stop is provided for each gang of spindles. A sliding movement of the clamping jaws is imparted by the horizontal lever to the right, by which means the work can be moved longitudinally to different positions for drilling any multiple of seventeen or thirty-four holes.

NEW MACHINERY AND TOOLS NOTES

Gap Grinder: Queen City Machine Tool Co., Cincinnati, Ohio. A machine of the standard type built by this company, except that the design has been modified to provide a gap and suitable water guard.

Threading Die: Conant & Donelson Co., Conway, Mass. This die has a hexagonal shaped guide which can be turned with an ordinary monkey wrench, making it possible to use the die for cutting over threads in places where there is not sufficient room to use a die stock.

Drilling Lathe: Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. An oil well tool drilling lathe designed for the special purpose of drilling slip sockets by power. The boring is accomplished by mounting the bar in the heavy drill slide or by using a flat drill.

Portable Grinder: N. A. Strand & Co., Chicago, Ill. A grinder intended for both internal and external work, which is arranged to give changes of speed suitable for the different sizes of grinding wheels employed. The connection between the machine and grinding wheel is by a flexible shaft.

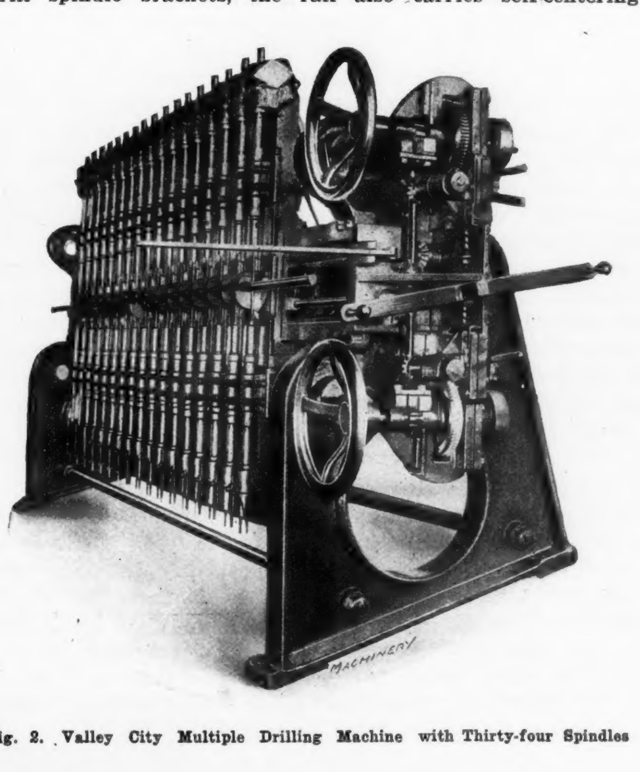


Fig. 2. Valley City Multiple Drilling Machine with Thirty-four Spindles

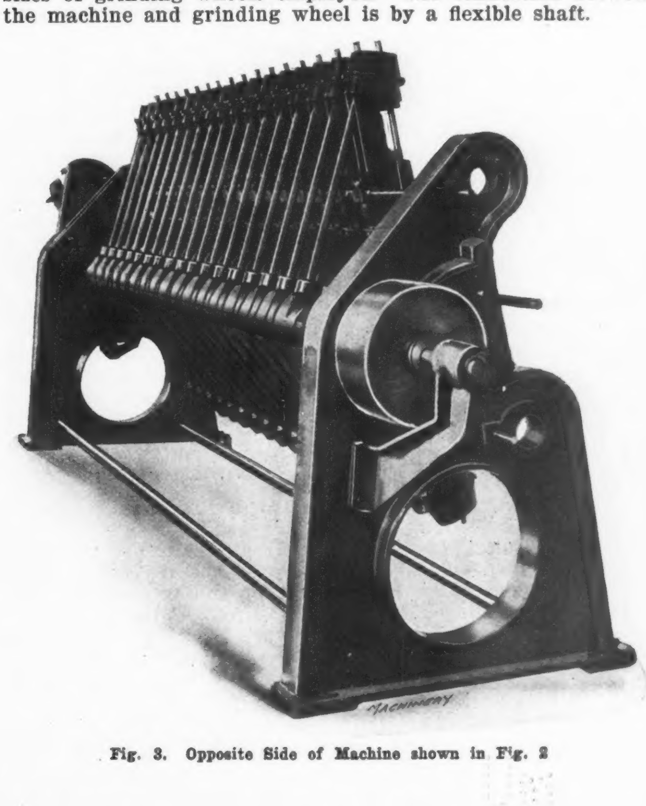


Fig. 3. Opposite Side of Machine shown in Fig. 2

Power Press Safeguard: Safety Engineering Co., Schofield Bldg., Cleveland, Ohio. This guard consists of a plate which is actuated from a cam on the shaft of the press, the plate traveling down in advance of the ram. Any obstruction over 1/8 inch in thickness prevents the plate from dropping far enough to enable the clutch to be engaged.

Patternmaker's Tool Chest: Union Tool Chest Works, Rochester, N. Y. This chest is fitted with five drawers and a top compartment. It is furnished with a leather shoulder strap for use in carrying the chest, in addition to a handle at the top. The chest is sufficiently strong to carry the class of tools which are used by patternmakers.

Reversing Motor Drive for Boring Machine: Electric Controller & Mfg. Co., Cleveland, Ohio. This device is particularly designed for machining short arcs on the boring mill, as it does away with the loss of time incident to carrying the table through a complete revolution for each cut, which takes place in a very small part of the revolution.

Lock Washer: National Umbrella Frame Co., 30th and Thompson Sts., Philadelphia, Pa. A lock washer of the split and warped ring type with a corrugated bearing surface which, it is claimed, is superior for this purpose to a lock washer with upset ends, owing to the fact that a more uniform bearing surface against the nut and backing is secured.

Slotting Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A heavy-duty, rack-driven slotter which is equipped with reversing motor drive, independent fast power traverse in both directions, push button control and operating levers on both sides of the machine. All levers are connected to prevent engagement of conflicting motions.

Pneumatic Forging Hammer: H. Edsil Barr, Erie, Pa. A light pneumatic hammer which operates on the same principle as a steam hammer. The anvil or die block is cast solid with the housing, which is reinforced on the inside and designed to support the cylinder. The valve is operated by a foot treadle so that both the workman's hands are at liberty.

Baling Press: Tempus Reclaiming & Mfg. Co., 441 N. 3rd St., Philadelphia, Pa. A portable press for baling metal scrap, tangled wire, turnings, etc. This press is particularly adapted for use in stamping works and similar plants where a large amount of the class of material referred to accumulates. The press is mounted on casters so that it may be moved about.

Projectile Turning Lathe: Niles-Bement-Pond Co., 111 Broadway, New York City. A heavy 30-inch lathe equipped with a 35-horsepower individual motor, which is particularly adapted for turning armor-piercing projectiles of all sizes up to 14 inches in diameter. The machine has been made exceptionally heavy in order to withstand the severity of the service for which it is intended.

Heavy Geared Head Lathe: Bridgeford Machine Tool Works, Rochester, N. Y. This machine is equipped with single pulley drive, and fifteen changes of speed, which are in geometrical progression, are available. Individual motor drive can be easily applied if so desired. The headstock gears run in oil and all shafts are bronze bushed. The swing is 33 inches over the ways and 22 inches over the carriage.

Triplex Hydraulic Pump: Watson-Stillman Co., 192 Fulton St., New York City. A line of high pressure hydraulic pumps which are driven by an individual motor mounted on an extension of the base. These pumps are of the triplex, single-acting type and the motor drive is direct connected. The construction has been worked out along lines which insure the maximum rigidity and maintenance of alignment.

Duplex Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A machine designed for automobile work but adapted for a wide range of milling operations where face mills can be used. The heads are mounted on vertical slides with the spindles opposed to each other, and an arbor may be mounted in both spindles and fitted with a cylindrical cutter to adapt the machine for slabbing operations.

Hydraulic Valve: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A five-way hydraulic valve designed to overcome the difficulty experienced by operators of double-acting hydraulic equipment in obtaining the desired pressure control. This valve is of the five-way, high and low pressure, double-acting balanced poppet operating type, and is said to be particularly well adapted to meet the requirements for which it was desgined.

Oxy-acetylene Welding Equipment: H. G. Davis, Springfield, Mass. A high-speed machine for automatically welding the seams of steel tanks, etc. The machine consists of two telescoping standards which support an I-beam from which two welding blow-pipes are hung over the revolving table. This table is entirely independent of the mechanism controlling the welding torches. It has four radial arms provided with clamps for holding the work.

Sixteen-inch Lathe: Von Wyck Machine Tool Co., Cincinnati, Ohio. A semi-quick-change gear lathe designed to meet the requirements of general manufacturing plants. This machine is built with either a three-step cone and double back gears or a four-step cone and single back gears. The feed-box gives four quick changes and is so arranged that only six loose gears are required to provide for cutting threads ranging from three to forty-two per inch.

Heavy Cutting-off Machine: George Gorton Machine Co., Racine, Wis. A cutting-off machine with a blade of the internal tooth type which has a capacity for cutting off any bar stock which can be passed through a circle 12 1/4 inches in diameter. The machine is equipped with a stock rack and trolley which has a measuring device to provide for cutting off pieces of specified lengths or for duplicating cuts. The bar to be cut is clamped in place by power.

Keyseating Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A vertical spindle keyseating milling machine which is said to be the first of its type built in the United States. The claim is made for this type of machine that better bearings for the keys are secured and the necessity of providing the clearance for the cutters by using a separate machine is done away with. A machine of this type is particularly valuable where short keyseats have to be milled.

Drilling Machine: Baker Bros., Toledo, Ohio. An automatic drilling machine for high-speed production. This machine automatically brings the work under the drill, advances the tool into the work, withdraws the tool and removes the work from the spindle without requiring any attention on the part of the operator. It is merely necessary to depress the treadle to drill each piece of work, so that a production of eight 1-inch holes per minute—including the chucking of the work—is maintained.

Automatic Sand Blast Machine: W. W. Sly Mfg. Co., Cleveland, Ohio. A machine particularly adapted for sand blasting small castings, which consists of a rotating table, half of which is constantly enclosed in a chamber in which the sand blast nozzles are located. The machine is built in five sizes which have table diameters ranging from 6 to 12 feet. The pieces to be sand blasted are set on the table and rotated under the nozzles which are arranged to blast all of the work uniformly.

Dial Measuring Gages: Randall & Stickney, 248 Ash St., Waltham, Mass. Two dial gages which are characterized by the simplicity of their design and construction. One of these gages is mounted on the support which carries a platen on which the work is placed preparatory to gaging. The platen is adjustable in all directions. The other gage referred to is adapted for testing the accuracy of a variety of work where a dial test indicator is required. The dial on both instruments is graduated to 0.001 inch, and metric gages can be furnished if required.

Electric Crane Trolley: Northern Engineering Works, Detroit, Mich. The most notable feature of this trolley is the care which has been given to the provision of safeguards at all danger points. The gearing is entirely enclosed, no gears are overhung and the hoisting gear case is made a part of the trolley, insuring rigidity and alignment of the gearing. Access to the gear case is had by lifting off the top half of the case. The trolley-travel gear case is of the same general construction. The wiring is of the latest type, being enclosed in steel conduits. A double system of electrical and mechanical brakes is used.

* * *

FAIR PLAY IN GETTING FOREIGN BUSINESS

Gov. Curtis Guild, of Massachusetts, sounded a warning note at the "Made in America" dinner of the Pilgrim Publicity Association in Boston. "To our shame," he said, "it must be admitted that, while most Americans have seen in this awful pestilence of bloodshed an occasion for sorrow, sympathy and acts of charity and mercy, some Americans have seen in it only an opportunity to imitate the action of birds of prey. Our commercial honor is in the limelight. We shall emerge from this war either with the hate or with the love of Europe—its hate if we take a mean advantage of Europe's disadvantage, its love if, ministering to its needs, we conduct our legitimate commerce in a spirit of manliness and integrity." He cited several cases of commercial dishonesty in filling orders.

* * *

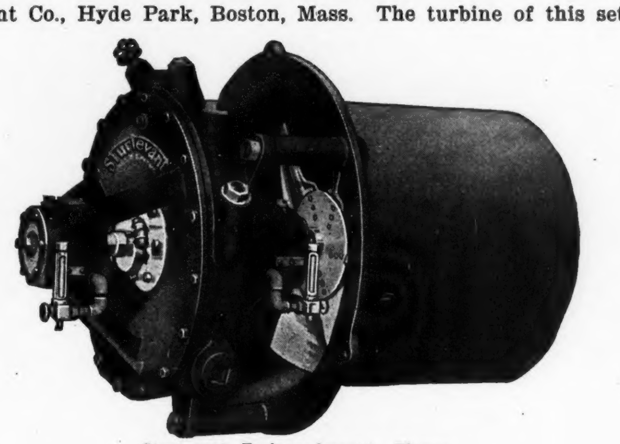
CORRECTIONS IN GRINDING ARTICLES

Errors of statement appeared in the article, "Crankshaft Grinding," August, 1914, in regard to the feed. The feed of 0.02 inch several times mentioned should obviously have read 0.002 inch. An error in regard to the hardness scale of Norton wheels was implied in the article, "Data on Surface and Cylindrical Grinding," in the December number, the implication being that an L wheel was softer than an N wheel. But the Norton hardness scale runs upward with the alphabet, and thus L wheels are softer than M and N wheels.

STURTEVANT TURBO-UNDERGRATE BLOWER

Turbo-undergrate blowers are now often employed in power plants where the chimney draft is insufficient to secure efficient combustion. Their use increases the rate of combustion and thereby increases the horsepower of the boilers, this increase ranging from 20 to 100 per cent according to conditions before the blower was installed. Additional advantages accruing from the use of turbo-undergrate blowers are that a cheaper grade of coal can be successfully burned, thus effecting an economy in the cost of fuel; and that a peak or emergency load can be carried without requiring extra boiler capacity. The blower is set in the boiler brickwork and can be easily installed without tying up the power plant.

The turbo-undergrate blower shown in the accompanying illustration is a recent addition to the line of the B. F. Sturtevant Co., Hyde Park, Boston, Mass. The turbine of this set



Sturtevant Turbo-undergrate Blower

is of practically the same design as the standard turbines built by this company. The bearings are provided with the ring-oiling system of lubrication, and the provision of a floating metallic stuffing-box makes it impossible for steam to get into the bearings. The casing is made very large which eliminates back pressure and tends to lower the steam consumption. The oil reservoir for the bearings when once filled, will last for weeks without further attention.

As in other designs of Sturtevant undergrate blowers, no ball bearings are employed, as experience has shown that the heat from the steam is apt to dry out the oil in the bearings and cause the balls to crack. An ideal nozzle control is provided, there being from one to six nozzles in use, according to the amount of steam required. The fireman can shut off any number of nozzles in order to obtain just the required amount of steam, and as a result high efficiency and minimum steam consumption are made possible. These blower sets are made in four sizes which have fans 14, 18, 22 and 26 inches in diameter, respectively.

* * *

SAFETY AND SANITATION CONFERENCE

A safety and sanitation conference was held in connection with America's Second Exposition of Safety and Sanitation at the Grand Central Palace, New York City, December 14-19. Each day of the conference was devoted to various phases of a chosen topic, as follows: Municipal safety day, fire prevention day, industrial safety day, transportation day, health day and employes' day. The program comprised a large number of papers, moving picture films and other instructive means of promoting industrial safety.

The exposition included 138 distinct exhibits made by railroads, manufacturers and inventors. On Thursday, December 17, the award of commemorative, bronze, silver and gold medals and grand prizes was announced at a luncheon in Delmonicos. Prof. F. R. Hutton, in giving the names of those to whom the prizes and medals were awarded, called attention to the two classes of exhibits to which awards were made. In one class are railroads, for example, with which transportation is the main object and safety a by-product. In the other class, safety is the principal object, inventions and devices having been made whose object is directly to prevent the occurrence of accidents.

PERSONALS

A. C. Cook, sales manager of Warner & Swasey Co., Cleveland, Ohio, sailed December 5 for a European business trip.

L. M. Waite, vice-president of the Fitchburg Machine Works, Fitchburg, Mass., sailed for a European business trip December 5.

Howard C. Murphy, draftsman at the United States Armory, Springfield, Mass., has been transferred to the Naval Torpedo Station at Newport, R. I.

Frederick A. Brower has been made manager of the Oswego Machine Works' New York City business with office in the Singer Bldg., 149 Broadway, New York City.

William M. Amidon, for fifty years employed in the toolmaking department of the Millers Falls Co., Millers Falls, Mass., has retired at the age of eighty years, still in good health.

Edward Blake, Jr., formerly manager of the J. T. Slocomb Co., Providence, R. I., has bought an interest in the Erving Mills near Greenfield, Mass., manufacturers of crepe paper goods and paper napkins.

George K. Atkinson, formerly with John Steptoe Shaper Co., Cincinnati, Ohio, and later manager of the Modern Machine Tool Co., of Cincinnati, has associated himself with the Steinle Turret Machine Co., Madison, Wis.

Francis Auberty and Capt. P. Gautard, engineers representing the French government, have been in this country for some weeks placing orders for machine tools, small tools and accessories for the government arsenals of France. They expect to be here several weeks longer.

Thomas F. Fournier, formerly efficiency engineer of the American Locomotive Co., and later district engineer of the Lamson Co., has been appointed chief engineer of the Becker Milling Machine Co., Hyde Park, Mass. Mr. Fournier will also direct the sales policy of the company.

Charles G. Smith, president and general manager of the Pittsburg Emery Wheel Co., Rochester, Pa., read a paper entitled "The Increased Efficiency in Economy Obtained by the Introduction of Safety Devices in Grinding Practice" before the Detroit Foundrymen's Association, December 10.

Heinrich J. Freyn has resigned as third vice-president of H. Koppers Co., Chicago, Ill. Mr. Freyn is a member of the American Iron & Steel Institute, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, etc., and resides at 5201 Harper Ave., Chicago. He has not yet announced his plans for the future.

Mrs. Frances A. W. McIntosh, formerly publicity manager of several industrial concerns, and well known in advertising circles, has resigned the position of automobile editor of the *Buffalo News*, Buffalo, N. Y., which she held for two years. Mrs. McIntosh has resumed her former work of advertising and catalogue compilation at 2200 Main St., Buffalo.

Kate Gleason, secretary and treasurer of the Gleason Works, Rochester, N. Y., has won the distinction of being the first woman admitted to the membership of the American Society of Mechanical Engineers. Miss Gleason took a mechanical engineering course in Cornell University and received practical training in the plant of her father, William Gleason, in building, estimating and selling machinery. At present she is reorganizing the Ingle Machine Co. Her specialty is designing gearing and estimating on same.

W. E. Welborne of Riga, Russia, is at present in this country in an endeavor to locate manufacturers of machine tools who wish to be actively represented in Russia. Mr. Welborne has been in this country since the latter part of October, and expects to stay here for a couple of months more. He has been instrumental in placing several large orders for machine tools with the Russian government so far, but is more desirous of establishing permanent connections with machine tool builders in this country to represent them in Russia. Mr. Welborne's address in New York is Hotel McAlpin.

* * *

OBITUARIES

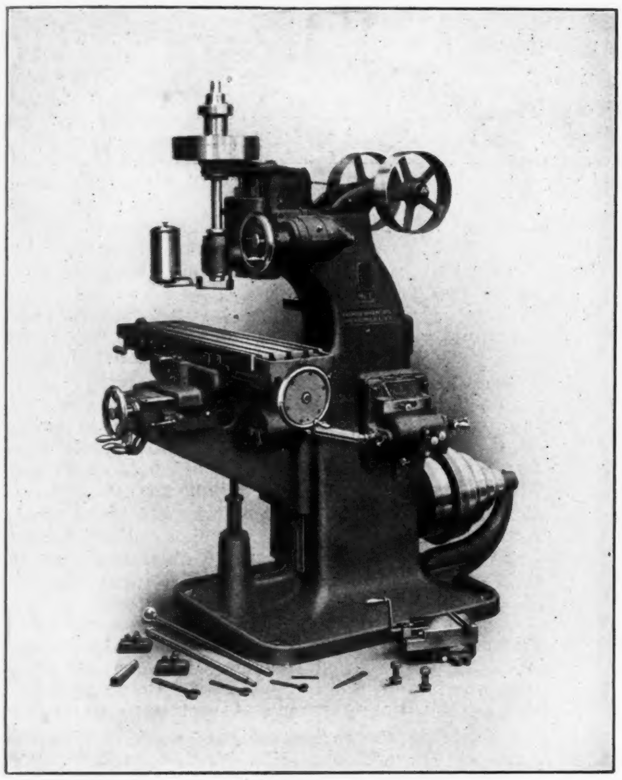
Morris G. Condon, senior member of H. B. Underwood & Co., Philadelphia, Pa., died December 3.

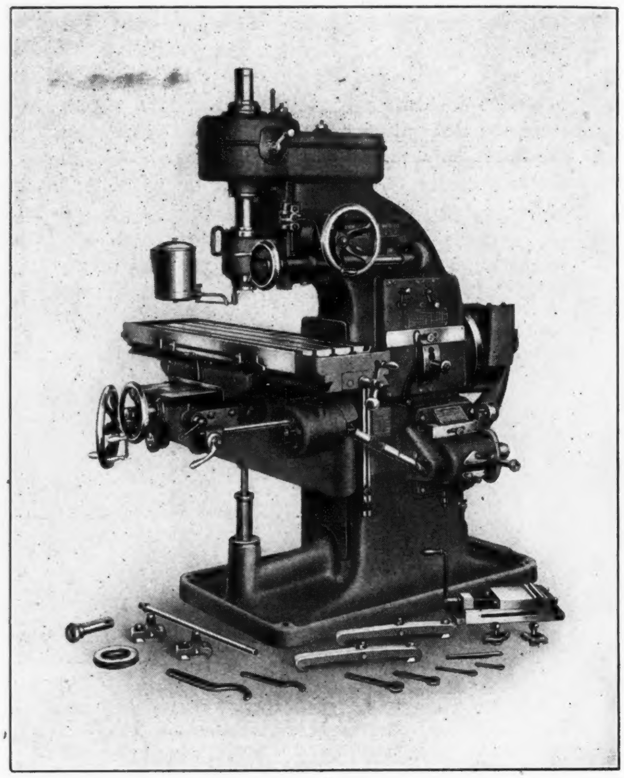
Alexander Harvey, secretary and treasurer of the Detrick & Harvey Machine Co., Baltimore, Md., died November 22.

Georges Bouillon, Paris representative of the Norton Co., Worcester, Mass., was killed in battle. Details and time of death not reported.

Lyman F. Gordon, president and treasurer of the Wyman & Gordon Co., Worcester, Mass., manufacturer of drop-forgings, died December 20, following an illness with rheumatic fever, aged fifty-three years. Mr. Gordon was born in Worcester and graduated from the Worcester Polytechnic Institute, mechanical engineering course, in 1881. In 1883 he formed a partnership with H. Winfield Wyman for the manufacture of drop-forgings. He was married in 1889 to Miss Prue Cox, and is survived by the widow and two children.

H. H. Frary, inventor of the Frary automatic wood turning lathe, died November 9 in Berlin, N. Y., aged eighty-seven





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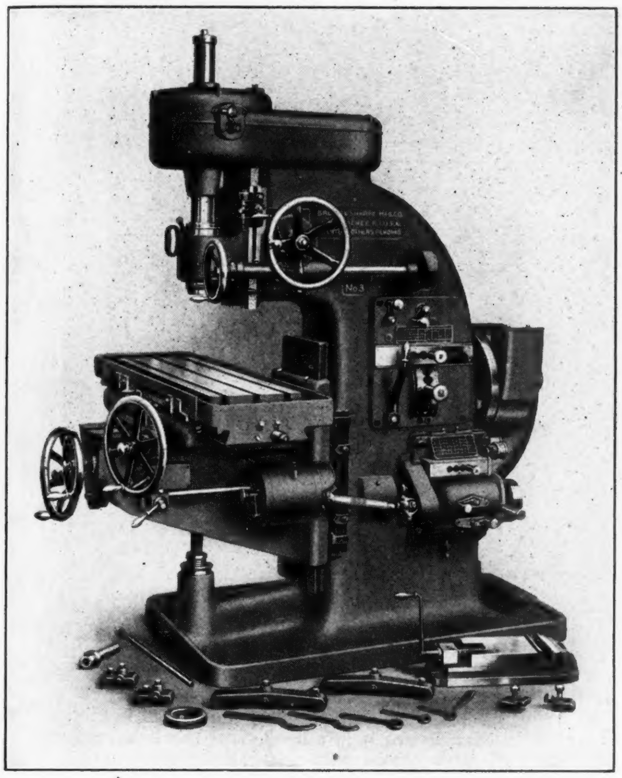

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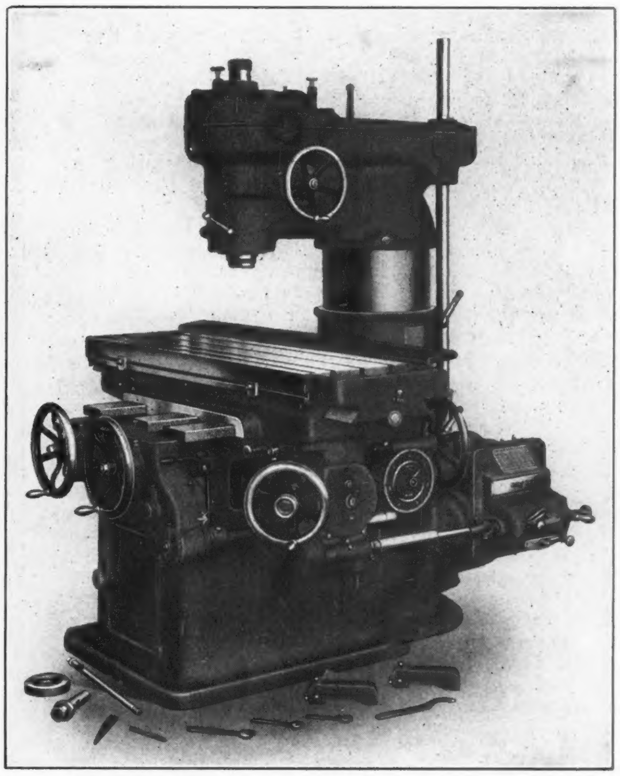

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CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon.
FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

READ PAGE 73

years. He had invented a number of machines and devices for making and finishing rolls and knobs for wall maps, and in 1866 he became interested in trying to produce small wood turnings automatically. After many vicissitudes and much discouragement, he finally brought into existence the lathe which is the progenitor of nearly all the automatic variety wood-turning lathes of the present. Among other inventions made was that of a machine for turning wooden shuttle bobbins.

Edward C. Page, vice-president of the Page-Storms Drop Forge Co., Chicopee, Mass., died December 14, aged forty-six years. Mr. Page was prominently identified with the manufacturing business of Chicopee and Chicopee Falls. The Page-Storms Drop Forge Co., one of the largest firms making drop-forgings in Massachusetts, was founded by Mr. Page and Frank F. Storms. Mr. Page received his early education in the public schools and graduated from Williston Seminary. He then became interested in the coal and wood business in Minneapolis, Minn., and after ten years, returned to Chicopee and entered the employ of the Lamb Knitting Machine Co., where he rose to the position of superintendent. He left the Lamb Knitting Machine Co. in 1902 to form the Page-Storms Drop Forge Co., entering into partnership with Mr. Storms. Mr. Page leaves a widow and two sons.

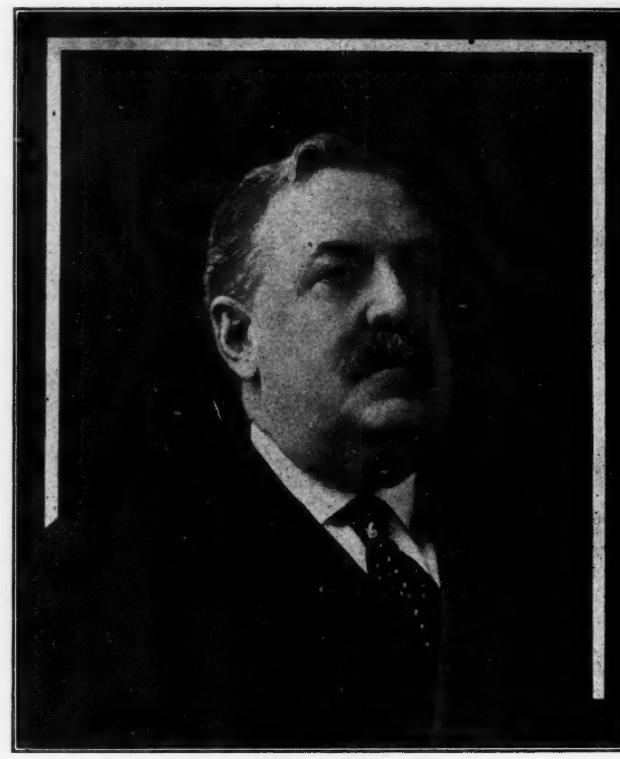
Austin F. Cushman, president of the Cushman Chuck Co., Hartford, Conn., died November 29, aged eighty-four years. He was born in Belchertown, Mass., and in early life learned the trade of carriage maker. He afterward drifted into patternmaking and was employed in various places, the last being the Colts Patent Fire Arms Mfg. Co. of Hartford. In 1862 he began the manufacture of chucks in a small way. The business prospered and in 1872 he built the factory which is now occupied by the company. The Cushman Chuck Co. was organized in 1885 and Mr. Cushman was made president, which position he held until his death. Many years ago he began to lose his eyesight and had been practically blind for the past fifteen or twenty years. While unable to give much attention to the details of the business, he had kept in touch with it and was at all times much interested in its progress. Mr. Cushman leaves a wife and one son, Eugene L. Cushman, the present secretary and treasurer of the company.

EDWARD D. MEIER

Col. Edward D. Meier, past-president of the American Society of Mechanical Engineers, and eminent in the profession, died December 15 at the home of his daughter in New York City, aged seventy-three years. He was born in St. Louis, Mo., and received a preliminary education in the country schools and then entered the Washington University of St. Louis. He spent four years at the Royal Polytechnic College, Hanover, Germany, and returned to the United States in 1862 and began his engineering career at the Mason Locomotive Works at Taunton, Mass. In 1863 he enlisted in the Union Army and remained in service until the close of the war in 1865. After the war he spent a year as machinist and draftsman at Rogers Locomotive Works in Paterson, N. J., and from 1867 to 1870 he was assistant superintendent and later general superintendent of the Kansas Pacific Ry. During the seventies he was engaged as a consulting mechanical engineer in the designing and building of machinery. In 1882 he began the development of the well-known Heine type of water tube boiler, and from 1885 until his death he was president and chief engineer of the Heine Safety Boiler Co. He was active in the promotion of the Diesel oil engine in the United States, being the first to call the attention of the American mechanical public to the high efficiency of this type of internal combustion engine. Col. Meier was elected president of the American Society of Mechanical Engineers in 1910. He was prominent in the joint meeting of the American Society of Mechanical Engineers and the Verein Deutscher Ingenieure in Germany in 1913, being chairman and spokesman of the party.

CHARLES A. MOORE

Charles A. Moore, president of Manning, Maxwell & Moore, Inc., New York City, died of heart disease on the steamer *Rotterdam* bound for Naples, December 8. Mr. Moore was born in West Sparta, N. Y., September 19, 1845, and educated in Massachusetts. During the Civil War, he enlisted in the Navy and served from 1862 to 1865. At the close of the war, he went into manufacturing in New England with characteristic push and enterprise. Mr. Moore was gifted with great energy and with a magnetic personality and kindly manner, which made him hosts of friends and contributed in no small measure to his great business success. Fifteen years of his early life were spent in New England and then he came to New York City, which offered larger opportunities to ambitious business men. The firm of Manning, Maxwell & Moore, familiarly known in the trade as the three M's, is a noteworthy one. Established in 1873 as H. S. Manning & Co., which title was changed in 1881 to Manning, Maxwell & Moore, the growth of the business has been steady and constant until it is now one of the largest of its kind in the world, with branches in all the principal cities in this country and Europe, controlling the Ashcroft Mfg. Co., Consolidated Safety Valve Co., Hayden & Derby Co., Hancock



Charles A. Moore

Inspirator Co., Shaw Electric Crane Co. and the United Injector Co. On the death of Mr. Maxwell, one of the original partners, about twenty years ago, his interest was taken up by his associates, and on the retirement of Mr. Henry S. Manning in 1905 his interest in the firm and its allied companies was sold to Mr. Moore, the sale having been arranged entirely by the two men principally interested, after a partnership of thirty-two years, without taking an inventory. Mr. Moore was one of the most widely known men in the machinery industry, but his interests were not limited to that field, as he also had a large acquaintance in railway, social and political circles. President McKinley and Senator Hanna were among his personal friends, and it is said that the former offered him a position in the Cabinet at his first election. Mr. Moore was a man of strong individuality and great energy; and while credit should be given to Mr. Manning's business ability and to the almost unlimited financial backing of his associates, the success of the firm was largely due to Mr. Moore's individual efforts. For the past four years Mr. Moore had suffered from heart trouble, and while he had not actually retired from the management of his large business interests he gave little attention to them.

* * *

FAKE WAR ORDER BUYERS

One product of the European war is a crowd of fake "buyers" of war supplies and material, who are using up the time of many of our manufacturers. Some of these "buyers" are simply irresponsible people who think they see an opportunity to make money out of the demand for war material, and others are plain gold-brick men. We advise all manufacturers to obtain sufficient cash with any war orders from unknown parties before the order is put in hand, and to get the rest of the money on delivery. This does not apply to legitimate machinery dealers here and in Europe, whose requirements merit careful attention.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly at New York City, required by the Act of August 24, 1912.

Editor, Fred E. Rogers	140-148 Lafayette St., New York
Managing Editor, None	
Business Managers { Alexander Luchars, President	" " " " "
Business Managers { M. J. O'Neill, General Manager	" " " " "
Publisher, The Industrial Press	" " " " "
Owners of one per cent or more of the stock:—	
The Industrial Press	" " " " "
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
H. L. Brown	" " " " "
Erik Oberg	" " " " "

There are no bondholders, mortgagees, or other security holders.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 30th day of September, 1914.

HARRY B. HEALEY,
Notary Public No. 84, Kings County,
Certificate filed in New York County No. 74.

(SEAL) (My commission expires March 30, 1916.)

COMING EVENTS

January 5-7.—Annual meeting of the Society of Automobile Engineers in New York City. Headquarters, Engineering Societies Bldg., 29 W. 39th St. Coker F. Clarkson, secretary, 1790 Broadway, New York City.

January 21-22.—Second National Foreign Trade Convention, in St. Louis, Mo.; object: "Greater prosperity through greater foreign trade." R. H. Patchin, secretary, 64 Stone St., New York City.

March 6-13.—"Made in the U. S. A." Industrial Exposition in Grand Central Palace, New York City. Harry A. Cochrane, manager, National Exposition Co., 200 Fifth Ave., New York City. The "Made in the U. S. A." exposition is being promoted to stimulate American trade with domestic and foreign buyers and to educate the American consuming public regarding American resources.

April 24-May 1.—Second Efficiency Exposition at the Grand Central Palace, New York City. Organized by the Efficiency Society, Inc., 41 Park Row, New York City.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

Massachusetts Institute of Technology, Cambridge, Mass. Catalogue of officers and students, with a statement of the requirements for admission and a description of the courses of instruction.

Pratt Institute, Ryerson St., Brooklyn, N. Y. The notice in the December number on page 348 calling attention to the free working library might have conveyed the impression that it is limited to 1200 books. The library contains over 100,000 books. The circular referred to the applied science room only, this being one of several reference and reading rooms in the library.

Society for Electrical Development, Inc., 29 W. 39th St., New York City, which has been organized for the purpose of promoting the use of electricity in the industries and the home, has issued two booklets entitled, "Household Electricity" and "Electricity in the Home," illustrating the great variety of electric devices on the market, designed to reduce the work of the housewife.

University of Illinois, Urbana, Ill. Circular of the research fellowships in the Engineering Experiment Station. Ten research fellowships have been established, for each of which there is an annual stipend of $500. Four of these were vacated with the close of 1914. Nominations to fellowships, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the director of the station each year not later than February 1.

NEW BOOKS AND PAMPHLETS

The Water Power Problem in the United States. By Rome G. Brown. 33 pages, 6 by 9 inches. Reprinted from the "Yale Law Journal," November, 1914.

Johnson's New Handy Manual on Plumbing, Heating, Ventilating and Mechanical Refrigeration. By John W. Johnson. 380 pages, 4 by 6½ inches. Published by the author, 850 Cass St., Chicago, Ill. Price by mail, $1.05.

This book, which has passed into the seventh edition, is made of a convenient size to carry in the pocket and is intended for practical everyday use by all classes of mechanics for which it is intended. It is profusely illustrated with diagrams to make the meaning of the text clear; it is devoted chiefly to plumbing, heating, ventilating and refrigerating work and hence has to do largely with piping systems of all sorts.

Casehardening. 47 pages, 6 by 9 inches. 15 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This book, which is No. 141 of MACHINERY'S Reference Books, contains a complete review of modern casehardening practice, dealing first with the subject in a general way, and then specifically taking up the casehardening practice in the bicycle, automobile and allied trades, the carbonization of shafting and the casehardening of roller bearing parts. One chapter of the book is devoted to new casehardening methods using carbonaceous gas for hardening instead of the usual packing materials. Important chapters to this book have been contributed by Robert H. Grant, the well-known ball-bearing expert, and E. F. Lake, consulting metallurgist and specialist on steel and its treatment.

Proceedings of Thirteenth Annual Convention of National Machine Tool Builders' Association. Held in New York City, October 22 and 23, 1914. Charles E. Hildreth, general manager, Worcester, Mass. 170 pages, 5¾ by 8¾ inches.

The proceedings appear in the usual attractive form. They comprise several general and technical papers and discussions of permanent value as follows: "Establishment of American Banking Facilities in South America," by H. R. Eldridge, vice-president of the National City Bank, New York City; "Reform in Drawing," by E. H. Fish, Worcester, Mass.; "Waste in Hiring and Discharging Employes," by Magnus W. Alexander of the General Electric Co., West Lynn, Mass.; "A Closer Commercial Relationship with Latin America," by James Logan, general manager of the United States Envelope Co., Worcester, Mass. The membership of the association listed is 158.

Machine Shop Practice. By William J. Kaup. 199 pages, 5 by 7½ inches. 163 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $1.25 net.

This is a manual for apprentices and journeymen machinists, and is intended especially for use in trade, technical and industrial schools. It is a revision of the author's work first published in 1911, the revision of the original work having been made for the purpose of making it more suitable as a school text and uniform with the Wiley technical series. It treats of chipping, filing, scraping, hand-tools, materials of construction, drill presses, planer and shaper practice, lathe practice, cutting tools, boring tools, milling machines, measuring instruments, gearing, grinding, tool steel and system. Each chapter concludes with a number of questions based on the preceding text.

Elementary Algebra. By Erik Oberg. 40 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

This book, which is No. 138 of MACHINERY'S Reference Books, may be said to be a practical treatise on the use of formulas, and the solving of mathematical problems by equations. The subject is in five chapters: The Use of Formulas; The Use of Equations in Solving Problems; Principles of Algebra; Equations of the First Degree and their Application to Mathematical Problems; Quadratic Equations and their Application to the Solving of Problems. The book is intended to make it possible for anyone with a knowledge of ordinary arithmetic to acquire rapidly and without a teacher the fundamental principles involved in the use of algebraic formulas and equations. The subject is treated in the most simple manner possible and only the essentials have been included. Mathematical discussions of merely theoretical interest have been eliminated and the book, therefore, should meet the requirements of men in practical work who desire to obtain a general knowledge of the subject of formulas and equations.

Safeguards for Machine Tools and Power Presses. 56 pages, 6 by 9 inches. 57 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

The prevention of accidents in the industries is a subject which, of late, has been given a great deal of attention by prominent engineers, engineering societies, and well-known manufacturing companies. The books on machine design in the past have given no information relating to the design of safety appliances. A book treating on this subject and containing, in addition, suggestions for preventing accidents, and rules for avoiding injuries should be welcomed by many. The book under review, which is No. 140 of MACHINERY'S Reference Books, contains five chapters headed as follows: Industrial Accidents and their Causes; Safety Devices for Machine Tools; Safeguards for Grinding Wheels; Safeguards for Power Presses; Rules for the Prevention of Accidents. The rules for the prevention of accidents are divided into suggestions and rules for the shop management and rules for employes. These have been collected from many sources, and contain many valuable hints and pointers relating to the safe operation of machinery in shops.

American Export Trade Directory for 1915. 369 pages, 6 by 9 inches. Published by the "American Exporter," 17 Battery Place, New York City. Price, $3.

This directory will be found especially valuable to American manufacturers who are looking at this time for new avenues to foreign trade. It is something more than a mere directory of names, containing information not readily obtainable by the manufacturer who wishes to know the facilities available for handling shipping and financing foreign orders. It makes known the fact that there are in New York City alone no less than seventy-three banking houses dealing in foreign exchange as a specialty. It lists 180 offices in New York City of foreign concerns or merchants. In addition, there are in this city no less than 605 export commission houses doing business with all parts of the world in manufactured articles and general products in the United States. The countries with which each of these concerns does business and the kinds of commodities in which each house deals chiefly are also given. Valuable information is given in regard to steamship lines in foreign service sailing from various American ports. No less than ninety-four American lines are listed as plying from New York to all parts of the world.

American Handbook for Electrical Engineers. Compiled by a staff of specialists under the direction of Harold Pender. 2023 pages, 4¼ by 7 inches. Published by John Wiley & Sons, New York City. Price, $5.

This handbook deals with the subject of electrical engineering and such phases of mechanical and civil engineering as are closely related to electrical engineering practice. In the preparation of this book, an interesting innovation has been made. The subjects dealt with in the book have been arranged alphabetically, and in this way it has been possible to segregate the theoretical discussions from the more practical matter, the handbook having been prepared primarily for the practicing engineer. Hence, in the sections dealing with practical matters only, just so much theory is included as to indicate the general principles. The range of subjects treated is wide, and while the handbook is primarily for electrical engineers, the method of treatment adopted is such as to make the book useful for reference also for mechanical, civil and mining engineers who have occasion to utilize any of the numerous applications of electricity in their special fields. Considerable space has been devoted to matters pertaining to applications of motors in all branches of modern industry. Numerous mathematical tables are also contained and the mathematical sections are clear and concise, the tables are well arranged, and the typographical appearance is a considerable improvement on most handbooks of the past. It is impossible to give an adequate idea of the contents on account of the fact that the subjects are arranged alphabetically, there being hundreds of sections, but it is certain that it is a book which will prove valuable to every electrical engineer and to all others who have to do with the applications of electrical machinery in the industries. As an indication of the wide scope of the handbook, it may be mentioned, however, that the following topics are covered by numerous articles: Mathematics; engineering materials; electricity and magnetism, principles and phenomena; batteries; laboratory instruments and apparatus; commercial electric instruments and apparatus; miscellaneous measuring instruments and apparatus; magnetic and dielectric testing; electric machinery and induction apparatus; control and protective apparatus; miscellaneous electric apparatus and their application; power stations; distribution and transmission; traction; photometry and illumination; industrial applications of electricity; telegraphy and telephony; electrochemistry; mechanical engineering; structural engineering; heat and steam engineering; hydraulic engineering; units, abbreviations and symbols.

NEW CATALOGUES AND CIRCULARS

Federal Name Plate & Novelty Co., 732 Federal St., Chicago, Ill. Circular of "New Process" name-plates made with raised letters and basket-weave pattern backgrounds.

Dalton Machine Co., Inc., 79 E. 130th St., New York City. Circular on the Dalton six-inch metal-working bench lathe supplied with or without column, and for foot power or electric drive.

American Die & Tool Co., Reading, Pa. Small catalogue of punches, dies, tools, etc., for bridge builders, structural iron workers, boiler makers, ship and car builders, automobile manufacturers, etc.

Joseph Dixon Crucible Co., Jersey City, N. J. Mailing card in the form of a barrel, advertising Dixon boiler graphite. The claim is made that boiler graphite reduces fuel consumption, prevents the hardening of scale, and preserves the interior of boilers.

Cincinnati Lathe & Tool Co., Oakley, Cincinnati, Ohio. Circular of the "F-P-M" turret tool-holder for lathes. This turret tool-holder differs from others in that no separate tool-holders are required for small tool bits, the bits being mounted in the turret itself and secured by set-screws.

Industrial Instrument Co., Foxboro, Mass. Bulletins 86 and 91 treating of "Foxboro" differential recording gages and orifice meters for gas, and Foxboro thermometers and thermographs, respectively. Descriptions of these instruments are given, together with reproduction of representative charts obtained by them.

Stow Mfg. Co., Binghamton, N. Y. Circular showing a number of the portable tools made by this company, among which are two-spindle drill, electric breast drill, universal drill, radial flexible boring machine, "Gee Whizz" machine for light drilling, boring, emery grinding, buffing, etc., tool-post grinder and electric hand buffer.

Eclipse Machine Co., Elmira, N. Y. Leaflet descriptive of the "Eclipse" roller bearing drill chuck that provides for an easy grip and insures against the drills slipping. The chucks are made in three sizes with capacities of 0 to 3/16, 0 to 3/8 and 0 to 17/32 inch, respectively. Price lists of the chucks and their separate parts are included.

Harding Distributing Co., Boston, Mass. Catalogue on the "Martell" aligning reamer, a reamer intended for scraping automobile crankshaft bearings. By means of this tool, bearings can be scraped so as to insure absolute alignment in a very short length of time. Bearings of motors can be reamed without removing the motor from the car.

T. A. Willson & Co., Inc., Reading, Pa. Catalogue of shop protection glasses. This catalogue was worked up with the idea of being helpful to men who are up against the problem of selecting proper eye protection glasses. It shows which styles are best suited to different kinds of work, the information being based on a study of actual shop conditions. Under separate headings, the styles most suitable for grinders, machinists, chippers, welders, etc., are suggested.

High-Speed Hammer Co., Rochester, N. Y. Loose-leaf catalogue containing specifications for the riveting machines made by this company, and instructions for operating them. These machines are built with bench base for light work and with pedestal base for average and heavy work. All the styles and sizes can be equipped with motor drive.

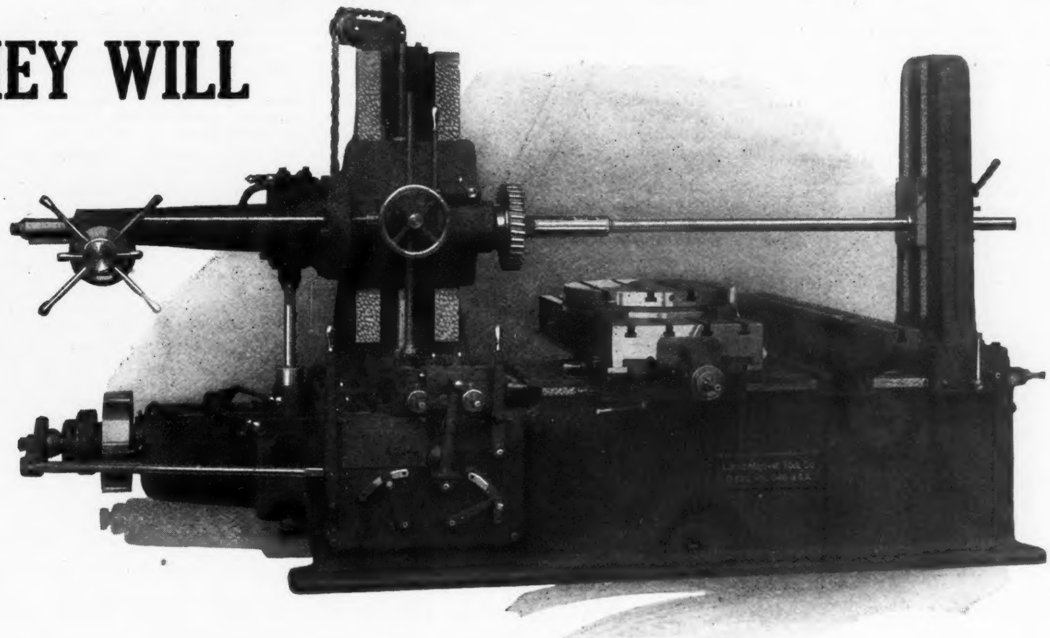
American Boiler Life Co., 19 N. Market St., Boston, Mass., is issuing a booklet entitled "Steam Boilers and Boiler Feed Water" that gives in simple, clear language useful suggestions for the care of steam boilers, founded on the experience of the company. The book has been carefully prepared and should be of interest to those in charge of steam boilers.

This Advertisement is OUR Investment;
Buying a Machine is YOUR Investment;
We BOTH Want Our Investments to PAY,

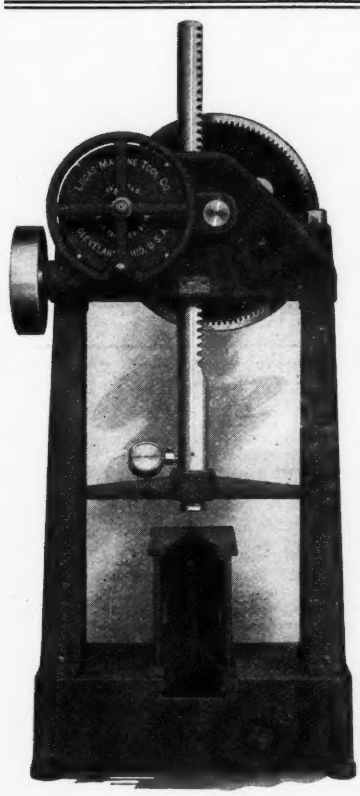
and if you buy the

LUCAS "PRECISION" BORING DRILLING MILLING MACHINE

THEY WILL



It is impossible to get something for nothing, and whatever comes out of a machine must FIRST be PUT IN.



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The BELT does the WORK

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Forcing bushings, arbors, etc., straightening, bending, broaching, marking, sealing valves for testing, assembling, armatures and transformers—a new use for the Press by almost every new customer.

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AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Petrograd. Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada. H. W. Petrie, Ltd., Toronto, Ont.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 34-S descriptive of small power-driven compressors, particularly suited to the requirements of garage owners, stone cutters, monumental works, electric stations, spraying outfits, etc. These compressors are built in two types —air-cooled and water-cooled—and can be driven by belt or electric motor.

T. A. Willson & Co., Inc., Reading, Pa. Safety service bulletin 4, a shop talk to the men on eye protection. It is a story of a workman who tells his fellow employe how "Bill" lost the sight of one eye by letting "Mike" use a dirty toothpick to remove a chip. The need of eye protection glasses for grinders and machinists is thus indicated.

Globe Machine & Stamping Co., Cleveland, Ohio, is publishing a house organ called "The Punch Press." It is a live, snappy publication similar to the "Silent Partner" which was founded, edited and published by the company, and which is now run as an independent magazine in New York City. The "Punch Press" advertises the activities of the company, and will be sent free to all concerns in the metal trades.

Watson-Stillman Co., 192 Fulton St., New York City. Leaflet giving prices and dimensions of "Kromax" "U" packings. The "Kromax" packing is made of leather, especially treated to withstand the hard wear to which packings are subjected. It withstands oil as well as water pressure, and is good for any pressure up to 10,000 pounds per square inch. Those employing these packings will be interested in the hints to users on pages 4 and 5.

Cincinnati Pulley Machinery Co., Cincinnati, Ohio. Catalogue illustrating and describing the firm's line of pulley machinery, designed for the special purpose of turning pulleys and similar work. Two types of pulley lathes are built, the Streit type and the Cincinnati high-duty type. The former is a friction feed machine made in five sizes, from 15 to 40 inches swing, and the latter is a geared feed machine built in 20- and 50-inch sizes. Pulley boring and drilling and tapping machines are also shown.

Boston Gear Works, Norfolk Downs, Mass. Booklet entitled "A Few Points regarding Our Gear Steels." This little book describes the two classes of special gear steel used by the Boston Gear Works and gives the physical properties of each. One grade is a low carbon steel for casehardening and the other is a higher carbon steel for oil-tempering. Some interesting illustrations of tests made on these two grades of steel are included. The specimens shown were not specially prepared, but were selected from regular work, and show remarkable durability.

S. K. F. Ball Bearing Co., 50 Church St., New York City. Circular of ball bearings for paper-making machinery, illustrated. The conditions imposed on bearings in paper-making machinery are severe, and the claim is made that S. K. F. ball bearings have proved successful under the most severe conditions in paper mills. The circular illustrates details of ball bearings applied to the various types of paper-making machines, comprising barkers, Jordan engines, Fourdrinier machines, cylinder paper machines, press rolls, dryer rolls, calenders and auxiliary equipment.

Lackawanna Steel Co., Lackawanna, N. Y. Catalogue describing the Lackawanna "deseaming" process for rail sections and the machines in which the operation is carried out. The deseaming process insures the production of rails free from the seams and similar defects that are so largely responsible for rail breakage. Briefly, it consists in milling off the surfaces of the bar while hot and during the rolling, sufficiently to secure freedom from surface defects. The rapidly rotating cutter is incorporated in the rail mill at a point where the partially formed rail lends itself readily to the cutting action.

Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill. Descriptive circular of "Thor" portable electric drills, the chief advantages of which are lightness, strength and durability. These drills are equipped throughout with ball and roller bearings, and are furnished with universal alternating or direct-current motors. Special attention has been given to the provision of safety devices in the design. The drills are made in sizes from 000 weighing 6 pounds and having a capacity of ¼ inch in steel, to No. 2 weighing 36 pounds and having a capacity of ⅞ inch in steel. Complete specifications for all the sizes are given in the circular.

Cochrane-Bly Co., Rochester, N. Y. Circular of the Cochrane-Bly No. 14 universal shaper, designed especially for tool- and die-making and applicable to a wide range of work on jigs, patterns, fixtures, cams, internal gears, broaching blind holes, etc. The machine comprises a vertical milling spindle and shaper ram mounted on the column and provided with universal adjustment, thus enabling work on the table to be machined at any angle. Otherwise the general construction is similar to that of a knee type milling machine. A circular table with compound slides provides for a wide range of circular and eccentric work. While designed for fine work, the powerful drive mechanism provides for heavy cuts when necessary to remove stock rapidly.

TRADE NOTES

Joseph Tracy, 1790 Broadway, New York City, has provided additional facilities in his motor-testing laboratory at East Rutherford, N. J., for carrying out investigations and tests of various kinds on steam engines, particularly of the turbine and rotary types. Tests can be conducted with both saturated and superheated steam.

C. & C. Electric & Mfg. Co., Garwood, N. J., has removed its Cincinnati office, in charge of F. A. Saylor, from the Greenwood Bldg. to 217 West Second St. Considerably more space has been provided in the new location to permit the carrying of a comparatively large stock, so that shipments can be made direct without waiting to receive material from the factory at Garwood.

American Roller Bearing Co., Pittsburg, Pa., will occupy its new plant at Melwood Ave. near Baum Boulevard, Pittsburg, Pa., about January 1. The new plant is of modern construction, being a reinforced concrete steel building with large windows to admit plenty of light. It affords practically four times the capacity of the present plant, and will be equipped with a large heat-treating department and modern equipment for the production of heavy types of roller bearings for all classes of machinery and equipment.

McInnes Steel Co., Ltd., Corry, Pa., manufacturer of vanadium high-speed, "Cello" oil-hardening, carbon and chrome-nickel steels; the Columbus Forge & Iron Co., Columbus, Ohio, specializing in machine and drop-forgings from ½ pound to 10,000 pounds weight; and the William G. Holmes Bronze Co., Bedford, Ohio, manufacturer of non-ferrous castings, have opened offices in Cleveland, Ohio, to take care of the Ohio territory, with George W. Radcliffe in charge. Mr. Radcliffe was for many years associated with Bassett-Presly Co., and recently was with Joseph T. Ryerson & Son of Chicago.